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ECONOMIC POLICY UNCERTAINTY AND OIL PRICE

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Abstract

This dissertation is intended to investigate the relationship between the uncertainty of economic policy and the price of oil. In this context it is given the appropriate weight to clarify this dynamic relationship, both through theoretical approach and by carrying out the appropriate econometric method. It is estimated the structural vector autoregression model with monthly data for the period from January 1994 until March 2015 for the United States. In this model the oil price shocks are divided into oil supply shocks, aggregate oil demand as well as precautionary oil demand shocks. Additionally, ten uncertainty indicators are taken into consideration: Consumer Confidence Indicator, Chicago Fed National Activity Index, Consumer Price Index, Conditional Volatility of Crude Oil, Equity Market Uncertainty Index, Economic Policy Uncertainty Index, Misery Index, Purchasing Managers Index, Realized Volatility of Crude Oil and Implied Volatility Index of S&P 500. The findings suggest that the side of the oil supply relative to the impulse responses functions into one standard deviation disorders for 24 months is the expected as there is insignificant impact on the most of the uncertainty indicators. Also, it is observed the expected and in the same directional response of the Chicago Fed National Activity Index in the supply of crude oil shocks. More specifically, according to the impulse responses functions at one standard deviation structural shocks from aggregate oil demand side the response of uncertainty indicators is the expected in most indicators. Exceptions and interesting findings have, the Misery index which shows a similar trend to the aggregate demand shock as well the Consumer Confidence Indicator, the Consumer Price Index and the Economic Policy Uncertainty Index that exercise insignificant impact. Finally, the results show that there is a significant and unexpected effect of precautionary oil demand to the half of the uncertainty indicators for up to two years, which deserves further investigation. The rest of the indicators have actual responses that match their theoretical approach compared to their attitude to economic policy uncertainty. In conclusion, the results of this dissertation are important because give the interesting visuals of the dynamic relationship between oil prices with the uncertainty of economic policy.

Keywords: Economic Policy Uncertainty, Oil Price Shock, Structural Vector Autoregression, Impulse Response Function

Περίληψη

Η παρούσα διπλωματική εργασία έχει ως στόχο να διερευνήσει τη σχέση ανάμεσα στην αβεβαιότητα της οικονομικής πολιτικής και στην τιμή του πετρελαίου. Στο πλαίσιο αυτής δίνεται το κατάλληλο βάρος στην αποσαφήνιση αυτής της δυναμικής σχέσης, τόσο μέσω της θεωρητικής προσέγγισης όσο και με την διεξαγωγή της κατάλληλης οικονομετρικής μεθόδου. Συγκεκριμένα, εκτιμάται το διανυσματικό διαρθρωτικό αυτοπαλίνδρομο υπόδειγμα με μηνιαία δεδομένα για την περίοδο από τον Ιανουάριο του 1994 μέχρι και τον Μάρτιο του 2015 για τις Ηνωμένες Πολιτείες της Αμερικής. Στο μοντέλο αυτό οι διαταραχές της τιμής του πετρελαίου έχουν διαχωριστεί σε διαταραχές προσφοράς, συνολικής ζήτησης καθώς και ειδικής ή προληπτικής ζήτησης πετρελαίου. Επιπλέον, λαμβάνονται υπόψη δέκα δείκτες αβεβαιότητας: Δείκτης Εμπιστοσύνης Καταναλωτών, Δείκτης Εθνικής Δραστηριότητας από την Ομοσπονδιακό Σύστημα Τραπεζών του Σικάγο, Δείκτης Τιμών Καταναλωτή, Δεσμευμένη Μεταβλητότητα του Αργού Πετρελαίου, Δείκτης Αβεβαιότητας Αγοράς Μετοχών, Δείκτης Αβεβαιότητας Οικονομικής Πολιτικής, Δείκτης Μιζέριας, Δείκτης Υπεύθυνων Προμηθειών, Πραγματοποιηθείσα Μεταβλητότητα του Αργού Πετρελαίου και ο Δείκτης Τεκμαρτής Μεταβλητότητας του S&P 500. Τα ευρήματα προτείνουν ότι από την πλευρά της προσφοράς πετρελαίου συγκριτικά με τις συναρτήσεις παλμικών αποκρίσεων σε μίας τυπικής απόκλισης διαταραχές για διάστημα 24 μηνών είναι οι αναμενόμενες καθώς δεν έχουν σημαντική επίδραση στους περισσότερους δείκτες αβεβαιότητας. Επίσης, παρατηρείται αναμενόμενη και ίδιας κατεύθυνσης απόκριση του δείκτη εθνικής δραστηριότητας από την Ομοσπονδιακό Σύστημα Τραπεζών του Σικάγο στις διαταραχές της προσφοράς του αργού πετρελαίου. Πιο συγκεκριμένα, σύμφωνα με τις συναρτήσεις παλμικών αποκρίσεων σε μίας τυπικής απόκλισης διαρθρωτικές διαταραχές συνολικής ζήτησης του πετρελαίου η απόκριση των δεικτών αβεβαιότητας είναι η προσδοκώμενη στους περισσοτέρους δείκτες. Εξαιρέσεις και ενδιαφέροντα ευρήματα έχουν, ο Δείκτης Μιζέριας που δείχνει παρόμοια τάση με τις διαταραχές της αθροιστικής ζήτησης πετρελαίου, καθώς και ο Δείκτης Εμπιστοσύνης Καταναλωτών, ο Δείκτης Τιμών Καταναλωτή και ο Δείκτης Οικονομικής Πολιτικής Αβεβαιότητας, οι οποίοι ασκούν αμελητέα επίπτωση. Τέλος, τα αποτελέσματα φανερώνουν πως υπάρχει σημαντική και μη αναμενόμενη επίδραση των διαταραχών της ειδικής ή μη προληπτικής ζήτησης στους μισούς από τους δείκτες αβεβαιότητας για διάστημα έως και δύο ετών, που χρήζουν περαιτέρω διερεύνησης. Οι υπόλοιποι δείκτες έχουν πραγματική απόκριση που ταιριάζει με την θεωρητική προσέγγιση τους συγκριτικά με την στάση τους απέναντι στην οικονομική πολιτική αβεβαιότητα. Συμπερασματικά, τα αποτελέσματα της διπλωματικής αυτής είναι σημαντικά γιατί δίνουν τις ενδιαφέρουσες οπτικές της δυναμικής σχέσης της τιμής του πετρελαίου με την αβεβαιότητα της οικονομικής πολιτικής.

Σημαντικοί όροι: Αβεβαιότητα Οικονομικής Πολιτικής, Διαταραχή στην Τιμή του Πετρελαίου, Διανυσματικό Διαρθρωτικό Αυτοπαλίνδρομο Υπόδειγμα, Συνάρτηση Παλμικής Απόκρισης

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Introduction

Over time, and particularly in the current conjunctures in which the world economy faces, the price of oil is one of the most significant variables, situated at the center of discussions and correlates strongly with the uncertainty of economic policy. Mainly in recent years the key interest of researchers and policymakers gather around the relationship of the impact of oil price shocks in total uncertainty of the international economic system.

Consequently, focusing on the United States, the main objective of this dissertation is to research into the impulse responses of selected measures that each one of them determine the uncertainty of economic policy from its own perspective, in relation always to the three oil price shocks (oil supply shocks, aggregate oil demand shocks and precautionary oil demand shocks), that occurred worldwide over the period 1994:01-2015:03. To achieve that, is employed the Structural Vector Autoregression model.

More specifically, this dissertation is structured as follows.

The Chapter 1 states the purpose and contribution of this dissertation on the relevant research topic.

With the help of the Chapter 2 is recorded the existing knowledge covers a large part of the research field that examines the connection between oil prices and the uncertainty in the financial world. In particular, initially referred to the necessary definitions on the price of oil and the main benchmarks of crude oil prices worldwide. In the sequel, it is presented the historical overview from 1862 to date which highlights the most important movements in the evolution of crude oil prices. Furthermore, it analyzes the relationship of changes and shocks in prices of oil with macroeconomic variables and financial markets.

Thereafter, it follows the decomposition of the oil price shocks into three parts (oil supply shock, aggregate oil demand shock and precautionary oil demand shock) and their connection with the uncertainty of the financial world. It is remarkable that this chapter presents and analyzes various indicators consistent with the uncertainty of whom ten were selected which helped to draw conclusions. Additionally, closing this chapter, it is applied analytical presentation of the Structural Vector Autoregression model, which is used for the research process. It allows the identification of oil price shocks and helps to illustrate their impact on uncertainty indicators.

Chapter 3 describes the methodology of Structural Vector Autoregression model which uses monthly data for the period 1994:01-2015:03. Moreover, the employed data are presented as well as the data sources. Specifically, the reduced-form Structural Vector Autoregression model is used and suitable restrictions are imposing in order to identify the disturbances in oil prices.

In Chapter 4 the empirical findings of the research are presented which focus on the actual impulse responses of the uncertainty indicators that are introduced in turn to the Structural Vector Autoregression model in relation to the three oil price shocks.

Finally, Chapter 5 summarizes the results of this dissertation and discusses about whether the actual response of the uncertainty indices to the three oil price shocks are similar or differ from the expectations set by the existing literature.

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Chapter 1

Aim and Contribution

Enormous interest is prevalent among policy makers and researchers for the oil price because crude oil is a leader commodity in the global economy and associated with the economic policy uncertainty. Especially, the global financial crisis of 2007-2009 contributed to further impulse about the aforementioned relationship.

Mainly attention is driven to how shifts in the price of oil affects to the uncertainty which is a section of economic policy. Furthermore, the price of oil expresses a dynamic interrelationship with the global economy and the economic policy uncertainty.

Consequently, the aim of the dissertation is to examine the dynamic linkage between Brent crude oil prices and economic policy uncertainty using monthly data over the period 1994:01-2015:03 for the United States.

The contribution of this dissertation is that:

- It provides evidence useful in policy-making, to researchers but also to investors that focus on prices for trading crude oil.
- It contains the oil price recursion and every major oil price shock in the history of crude oil.
- It stresses the importance of the decomposition of oil price shocks into three types (oil supply shocks, aggregate oil demand shocks and precautionary oil demand shocks) for capturing the strong relationship of the uncertainty and the oil price.
- It emphasises the use of the Structural VAR model that captures the impulse responses of the three oil price shocks to the corresponding measures of uncertainty.
- It summarises information important for those who would like to forecast the price of crude oil.
- It could constitute motivation for further investigation not only for the United States but for other countries as well.

Chapter 2

Literature Review

2.1 Oil Price

Increased interest prevails in scientific and wider scope as regards the price of oil, yet parallel combined with economic policy uncertainty. One of the most significant commodities internationally is the crude oil, as discussed in Hubbard (1998).

Many researchers focus on the association of these two key variables and trying to develop their own point of view. Specifically, several of them make another attempt to identify oil demand and oil supply shocks on the economy, in order to capture the disruptions during important historical episodes[1].

Beginning with the necessary definitions for the determination of the research issues, the price of oil, concerns the spot price of a barrel of benchmark crude oil. The determination of the price of a barrel is strongly connected with the following factors: its grade and its location[2]. In a barrel allocated 159 liters (42 US gallons) of crude oil[3].

The main benchmarks of crude oil internationally which are illustrated in Figure 1, are the following:

- "Brent Blend" (Brent).
- "West Texas Intermediate" (WTI).
- "Dubai/Oman".
- "OPEC Reference Basket" (ORB).

"Brent Blend" (Brent)

Specifically, the Brent Blend crude oil is the most prevalent as it includes two thirds of the crude oil contracts worldwide. Also, contains the four fields' crude oil of North Sea which are the following, Brent, Oseberg, Ekofisk and Forties.

According to Maghyereh (2004), the benchmark Brent crude oil is mostly used because it represents the 60% of the international intraday oil production. Filis *et al.*, (2011) choose Brent crude oil as a proxy of the global oil price for the examination of the effects of oil price shocks on the economy.

Still other researcher such as Wei *et al.*, (2010), attempted to detect attributes and volatility of both crude oil markets, Brent and West Texas Intermediate.

"West Texas Intermediate" (WTI)

Moreover, for the United States the main reference point for the oil consumption is the West Texas Intermediate. In particular, supplies of West Texas Intermediate crude oil are more expensive than the other supplies of crude oil benchmarks, because after the procedure of drilling, the oil is transferred to Cushing, Oklahoma, through a pipeline.

[1] In details, authors that dealt with oil price shocks, are: Kilian (2009), Hamilton (1983), Hamilton (1988a, 1988b), Kilian and Park (2009), Hooker (2002), Jimenez-Rodriguez and Sanchez (2005), Sadorsky (1999), Park and Ratti (2008) and Nordhaus (2007).

[2] https://en.wikipedia.org/wiki/Price_of_oil

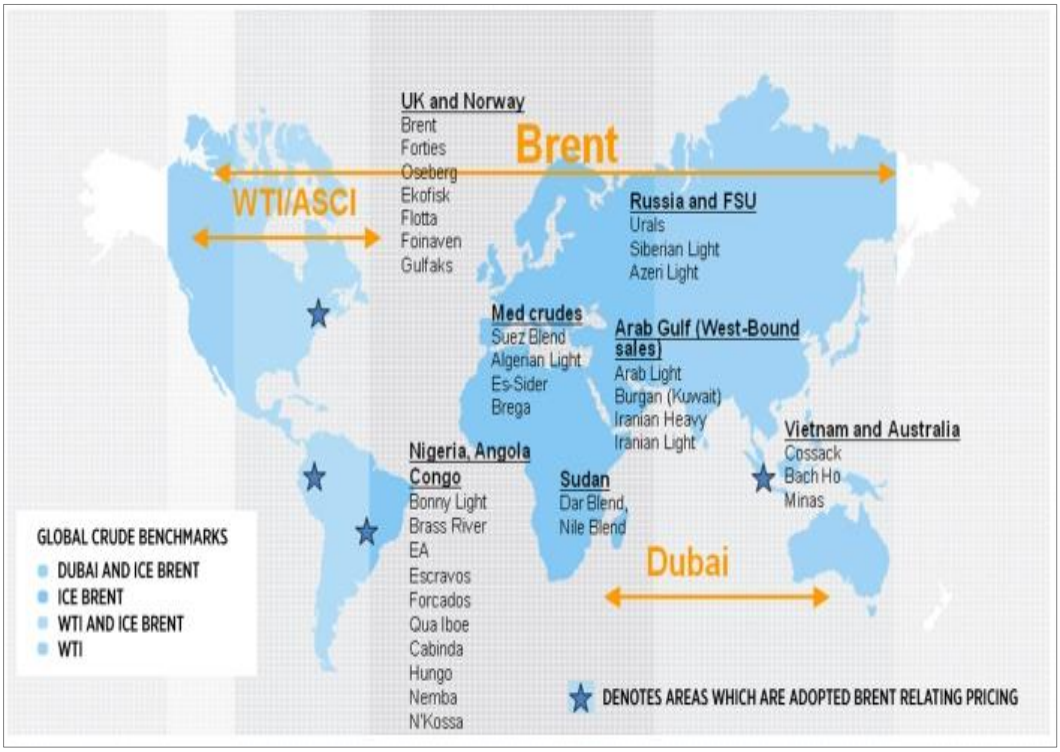
[3] https://en.wikipedia.org/wiki/Barrel_%28unit%29

Much of the existing literature supports its conclusions in data derived from the West Texas Intermediate crude oil benchmark, indicatively reported the following, Lee and Chiou (2011), Sévi (2014), Wei *et al.*, (2010), Arouri *et al.*, (2012), Efimova and Serletis (2014), Wang and Wu (2012), Chkili *et al.*, (2014), Alquist *et al.*, (2011) and Baumeister and Kilian (2012), among others.

"Dubai/Oman"

In addition, Dubai/Oman is rated on the lower range compared with the two aforementioned benchmarks for crude oil and also includes the extracting oil from the Middle East region such as Oman, Dubai and Abu Dhabi. Thus, is mainly exported to Asia and is known as the oil of the Persian Gulf[4].

Figure 1: *The Main Crude Oil Benchmarks Internationally*



Source: *Intercontinental Exchange (ICE)*

"OPEC Reference Basket" (ORB)

Furthermore, another important reference point for crude oil is OPEC Reference Basket (ORB), as referred to member countries that produce oil, is based mainly on oil prices in Arabia. In particular, it is a weighted average of the prices for petroleum mixtures of these countries and is heavier than the Brent and West Texas Intermediate crude oil.

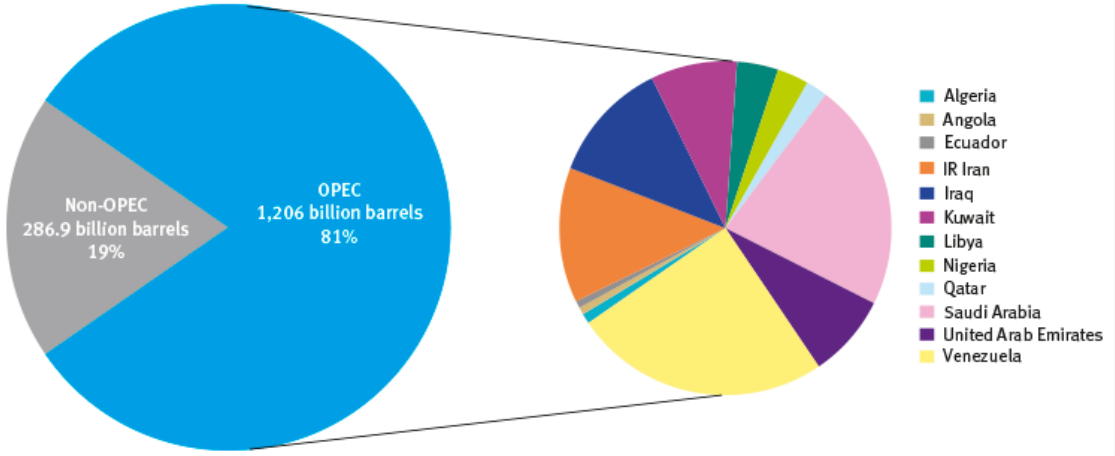
Initially, in 1928 the price of oil was determined monopolistically from the countries-producers of crude oil, among 1970 the long-term dominance was interrupted and the whole control passes to international Organization of the Petroleum Exporting Countries (OPEC).

[4] https://en.wikipedia.org/wiki/Dubai_Crude

Undoubtable, the OPEC, controls the oil market and affects the price of oil. Members of OPEC are the following twelve oil exporting countries, Algeria, Angola, Ecuador, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates and Venezuela[5].

OPEC's main function is meant to balance the different policies of producing countries oil to protect their own interests but also to ensure adequate stability in oil prices. Notably, OPEC aims at the satisfaction of both parties involved in the economic system, to consumers and producers, on the one hand by providing a constant amount of oil in order to meet the demand and on the other hand providing security on the return of the investments in producers. Below, Figure 2, presents the OPEC's share of world crude oil reserves in 2014.

Figure 2: *OPEC's Share of World Crude Oil Reserves in 2014*



OPEC proven crude oil reserves, at end of 2014 ***(billion barrels, OPEC share)***

Venezuela	299.95	24.9%	Iraq	143.07	11.9%	Libya	48.36	4.0%	Algeria	12.20	1.0%
Saudi Arabia	266.58	22.1%	Kuwait	101.50	8.4%	Nigeria	37.07	3.1%	Angola	8.42	0.7%
IR Iran	157.53	13.1%	UAE	97.80	8.1%	Qatar	25.24	2.1%	Ecuador	8.27	0.7%

Source: *OPEC Annual Statistical Bulletin 2015*

Here are other benchmarks of crude oil[6], such as:

- **"Minas"**, which is lightweight and mined from the island of Sumatra, known as Sumatran Light. Similarly, and the following categories are very light crude oil types,
- **"Tapis"** from Malaysia that is characterized as the most expensive crude oil, which is a result of non-supply to Asian countries by major benchmarks of crude oil, Brent and West Texas Intermediate, and because of its excellent quality.
- **"Bonn light"** which is mined from Nigeria as well as,
- **"Isthmus-34 Light"** that is produced in Mexico.

[5] http://www.opec.org/opec_web/en/about_us/25.htm
[6] http://www.petroleum.co.uk/api

Oil Producing Countries

The fifteen leading oil-producing countries worldwide, which in 2014 shipped the 82.1% of the crude oil that is expressed in dollars' value, are listed in Table 1, in descending order.

Table 1: *The Fifteen Oil-Producing Countries, the Dollars that These Countries Received and the Percentage that is Covering Overall Exports in 2014*

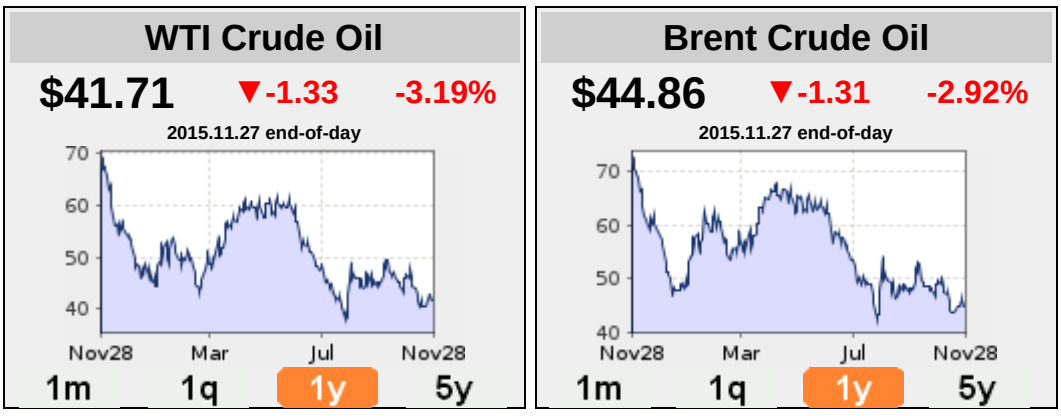
Oil-Producing Countries	Dollars that oil-producing countries received in 2014	Percentage which is covering overall exports in 2014
Saudi Arabia	$ 268.2 billion	18.5%
Russia	$ 152.6 billion	10.5%
United Arab Emirates	$ 98.0 billion	6.8%
Canada	$ 88.1 billion	6.1%
Iraq	$ 84.4 billion	5.8%
Nigeria	$ 76.2 billion	5.3%
Kuwait	$ 69.3 billion	4.8%
Angola	$ 61.2 billion	4.2%
Kazakhstan	$ 53.6 billion	3.7%
Venezuela	$ 53.3 billion	3.7%
Norway	$ 44.2 billion	3.0%
Iran	$ 41.3 billion	2.8%
Mexico	$ 36.2 billion	2.5%
Oman	$ 34.8 billion	2.4%
United Kingdom	$ 29.0 billion	2.0%

Source: *http://www.worldstopexports.com/worlds-top-oil-exports-country/3188*

Current Oil Price

At present interval oil prices are low and stand out in global economic history, specifically, WTI crude oil is $ 41.71 and Brent crude oil is $ 44.86[7]. Figure 3, illustrates annual data for two of the main crude oil prices, WTI and Brent, for the November of 2015, expressed in dollars.

Figure 3: *West Texas Intermediate and Brent Crude Oil Prices Expressed in Dollars, Annual Data of November 2015*



Source: *http://www.oil-price.net/*

[7] http://www.oil-price.net/

2.2 Historical Oil Price Movements

The price of crude oil dynamically evolves over time and, like other commodities with international scope affected by the global economic and political events, such as economic recession, production and consumption shocks, military events, terrorism, political tensions and speculative attacks among other. Structural chronological order of movements of oil prices during the variety of important facts the economic history are illustrated at Figure 4, are presented below.

Oil Price in the Pre-1990 Period

The first oil crisis occurred in the period 1862-1865[8]. At that time, the civil war that erupted in the United States led to an upward trend of prices of goods and consequently of the crude oil, but also in taxation on competing illuminant that in total resulted in an increase in oil prices. Subsequently, the period of 1865-1899 that followed was characterized as evolutionary for industry. The explosive oil prices and fluctuations came from drilling in the United States. In particular, the sub-periods 1891-1894, the contribution of oilfields of Pennsylvania was crucial to the rise in price of oil. Also, the recession and the dynamic production by the United States as well as from Russia in 1890-1892 threw the height of the price of oil, as discussed in Hamilton (2010).

In 1920, there was a rapid appearance of the car, which in turn led to growth of consumption of oil but also in the "West Coast Gasoline Famine". Oil prices noted historical low records in 1931 as the beginning of the Great Depression but also from the state regulation that managed to reduce the demand of oil. The postwar period 1947-1948 as reported and Alquist *et al.*, (2011), the explosion of the automobile led to reduce the stocks of oil in certain areas of the United States.

Moving in the 1950s, and specifically at the beginning of the 1952-1953 oil price was entrenched as it was in progress, the war in Korea. In 1956-1957, the crisis that erupted in Suez, the Suez was not able to obtain a tenth of international oil index, while parallel the oil production in the Middle East continued to grow and thus the oil price levels were balanced and high prices were avoided.

Concatenated dramatic events that took place in the 1970s, reached the price of crude oil above $ 40 per barrel by the end of this decade. In 1972, is observed a peak in oil production of the United States while the next period 1973-1974, the Arab states adopt an embargo on countries supporting Israel in the Yom Kippur war, doubling oil prices as mentioned Hamilton (2010). The Iranian revolution in 1978-1979, was a determining factor after it led to oil prices at high levels through the actions of, more specifically led to cuts in production and of exports as long as it lasted. Also, it was extremely harmful to the United States by interrupting contracts with companies. More comprehensive, the price of crude oil from $ 14 a barrel in 1978 reached up to $ 35 in 1981[9].

Borderline of history, constitutes the war that flared between Iran and Iraq which of course had as the impact of late oil exporter in the world's economic balance. Thus the increased demand coupled with the problem of oil supply because of the war push oil prices down. In crude oil production enters dynamically and Saudi Arabia in

[8] https://en.wikipedia.org/wiki/Oil_crisis
[9] http://www.eia.gov/

1986, recovering significant global market share. In 1988, the war zones of Iran and Iran stopped the war, winning wasted time and yielding more oil.

Oil Price in the Post-1990 Period

In the early 1990s, is recorded the first Gulf War with Iraq to invade Kuwait and the oil price range at $ 44 a barrel. At the end of year 1991, the oil was costing $ 21 per barrel. Between, 1992-1995, the price of oil had a relatively low volatility and was relatively small. The Asian financial crisis of 1997-1998 led to the crash of oil prices worldwide causing great volatility. While in early 1999 the Asian demand for oil has recovered well after the economic crisis, in 2000 the industrialization of China with the parallel increased demand for oil, led to a peak in oil prices in the world market. During this period, the spare capacity of Saudi Arabia is declining. According to Zhang and Chen (2011), volatility of world prices of oil has correlation with stock returns of China.

Specifically, in 2001-2003 observed low level of oil prices up to $ 20 a barrel at the end of 2001. Undoubtedly, terrorism attack of 9/11 of the year 2001 in the United States established evident instability in the price of oil worldwide. Benati (2014) refers to the aftermath of 9/11, which played an important role in increasing uncertainty. Moreover, the troubled state of that time in the Middle East by both the second Gulf War but with the turmoil in Venezuela also led to a sharp increase in price volatility in the short term.

Subsequently, going to the 2004-2007 oil price has been rising up and a threefold increase in the middle of the year 2007[10]. In 2007-2008, with the outbreak of the global financial crisis there was growing demand for oil and other fixed amounts of supplies. Features of this critical period the price of oil from the unusually high price, $ 140 a barrel, plummeted to $ 33 by the middle of 2008. The volatility on the price of oil was immense and many authors studied the implications of this the crisis in oil prices.

More specifically the Bloom (2009) and Bachmann *et al.*, (2010), approached the main macroeconomic variables of the global economy and the impact of uncertainty in relation to the oil factor. In 2011, the civil war disrupts the Libyan oil production. In mid-2013-2014, in the perspective of action of the United States in Syria entail raising price of petroleum ranging internationally to $ 110 per barrel.

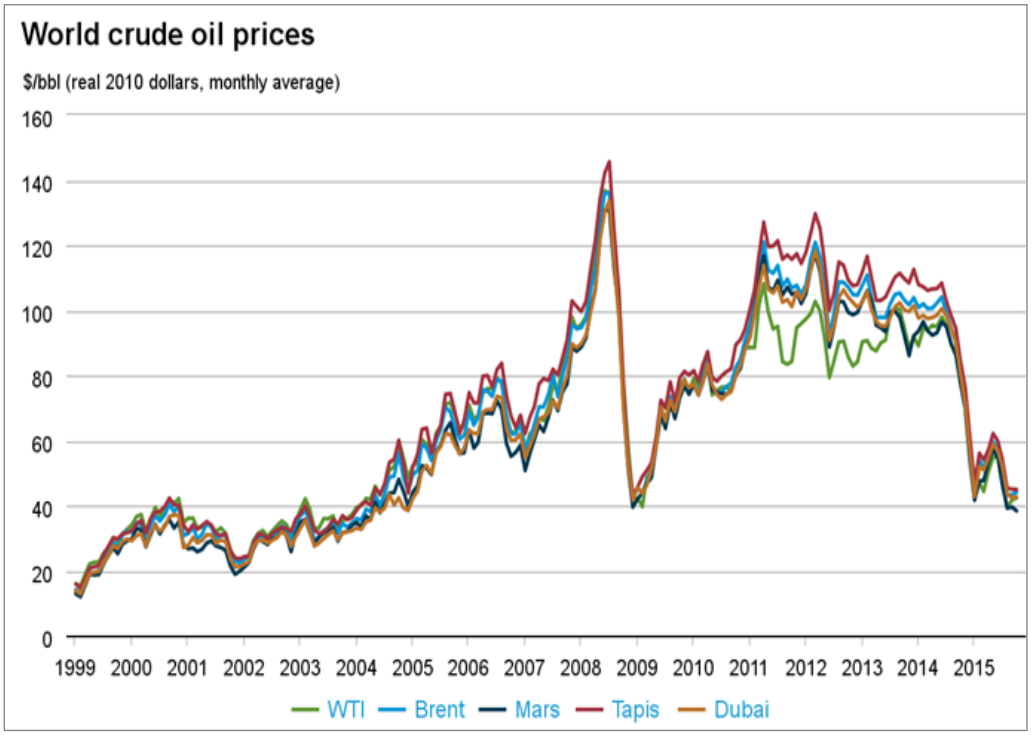
The year 2014 was characterized by disturbances in the oil price in the global oversupply this year to expand in 2015. According to Hamilton (2014), much of the decline in the price of oil, especially from mid-2014, comes from the strong global demand for oil in Europe and China, but also from increased oil inventories. Initially, the price of oil in 2014 stood at $ 108 a barrel due to sluggish global demand with the main injury factor, the reduced demand from the huge oil importer, China. Since September 2014, the focus in the case of oil at $ 40 per barrel as well uncertainty tremendously, pushes at the end of this year the price of oil at $ 60 a barrel. Passing in 2015 and especially in august the price of oil fells to $ 40 per barrel, the largest reduction in five years because of the sharp drop in demand of China as the same period that brought a lot of uncertainty about the economy of this major player[11].

In general, historical data have shown that the oil sector is robust and the oil prices are rarely stable for long periods. Hence, the crude oil sector is capable of

[10] http://www.eia.gov/
[11] http://oilprice.com/Energy/

adapting to changes and uncertainty resulting from the various conditions that leads to prosperity.

Figure 4: *International Crude Oil Prices in Real 2010 Dollars, Monthly Average Data from 1999 to 2015*



Source: *U.S. Energy Information Administration (EIA)*

2.3 Oil Price Changes to Macroeconomic Variables and Financial Markets

Crude oil is an important factor in the production process and therefore an increase in the price of accordance with Backus and Crucini (2000) will lead to increased production costs.

Moreover, such increases to the price of oil according to Hamilton (2008) had impact to the majority of the recessions in the United States since World War II. In addition, Filis and Chatziantoniou (2013), Balke *et al.*, (2010) and Filis (2010), suggest that important implications on inflation and industrial production comes from the oil prices.

The prosperity of oil-importing and oil-producing economies is harmed by the fluctuations that remain for large periods in the price of oil as discussed in Alquist *et al.*, (2011). Therefore, the varying prices associated with crude oil have vital effects for both oil importing and oil exporting countries.

According to Arouri and Nguyen (2010) an increase in oil price will have the effect of increasing the cost of production, as the crude oil is an integral part of the production. The consequences of the increase in oil price will pay particularly consumers. Therefore, the consumers in turn will reduce the consumption which

successively will negatively affect and production of oil as well as the unemployment, as referred to Hamilton (1996), Hamilton (1988a, 1988b), Bernanke (2006) and Abel and Bernanke (2001).

Reductions in the price of crude oil have direct and indirect effects on economic activity as it is one of the dominant tradable good among others. More precisely, it affects the crude oil market, the inflation, investment and economic growth.

Especially, increases in the price of oil would have harmful consequences for the countries that import crude oil according to Hooker (2002), but the expected reactions of oil producing countries in oil price increase is positive as these countries will increase their revenue and will be able to invest. Thereby, increasing their productivity will increase jobs in the sector, as discussed by Bjørnland (2009).

As regards the crucial determinants of the oil price, are based on the economic theory factors of supply and demand in link with the global economic sentiment. The demand of oil depends on macroeconomic factors and equivalent, the supply of oil is consistent with the legal and tax regime of oil producing countries, with the discovering of new geological oil deposit, with the financial burden of these countries in order to extract crude oil, with the available technology-innovation as well as with the political instability of oil-producing countries.

The literature contains numerous approaches and investigations on the effect of macroeconomic variables to changes in oil price. Such macroeconomic variables such as inflation, the real growth domestic product, the employment and exchange rates mentioned among the many authors for example Hamilton (1983), Hooker (1996), Lee and Ni (2002) and Hooker (2002).

Broadly, the price of oil is influenced from a range of factors such as macroeconomic, geopolitical flashpoints, political or military crises, global financial recessions, speculation, globalization, seasonality and weather conditions. Specific, the geopolitical crises are some of the most powerful current movers of oil price.

More specifically, according to Baumeister and Kilian (2012) the key variables about oil price determination are the global oil production, the global real economic activity and the above ground crude oil inventories.

The economic and socio-political instability affects to the international supply and demand for energy and in turn changes the price of oil. Natal (2012) and Montoro (2012), attempted to link among an oil price change and the consequences to inflation and to production output. Malliaris and Malliaris (2013), argue that inflationary pressures have a strong impact on the oil price. Another view claims that the oil-producing countries will acquire worrying climate when oil price reaches at high levels, as referred to El Anshasy and Bradley (2012).

One reason that explains why during the period of low oil prices may not changes the oil demand, are the exchange rates. In particular, the dollar is the international currency that expresses the price of oil. The strength of the dollar compared to other world currencies leads the United States in privileged position compared to the low level of oil prices. Instead, the rest of the economy does not receive the same treatment while enjoying only a part of this decline in prices of oil and in turn reduces demand for crude oil.

In the major factors that affect in the oil market are speculators, who are betting on the fluctuations which will occur in the demand and the offer price, which in turn will affect the price of some petroleum products upwards or downwards. A

relevant approach on the price of oil and speculation, applied by Cifarelli and Paladino (2010), arriving at the conclusion that between changes in the oil price there is negative association with stock price and changes in foreign exchange rates.

As reported to Kilian (2009), the case of speculative oil demand shock is similar to the case of the oil supply shock but not to the extent that will affect the future oil production worldwide. The impact of speculation shock in demand of oil has more immediate and sustained influence to the price of crude oil internationally.

Also, Baumeister and Kilian (2012) point out that if speculation mobilized by the oil exporting countries then the oil prices would rise rapidly as the crude oil production will be deliberately delaying.

The American shale oil production which is refined from sedimentary rock, is another element that impacts oil price, by covering the domestic demand, reducing crude oil imports at United States and from 2010 has major long-standing extraction industries which are operating in Estonia, Brazil, and China that turned the United States into the world's largest fuel exporter[12].

The United States, at the end of 2014 produced more than nine million barrels of oil a day, recording an increase of 80 percent from 2007. This production has a large oil reserve which in turn led to low oil prices[13]. Also, Alquist *et al.*, (2011) adjust the oil price data to the United States inflation, using West Texas Intermediate as a proxy for the price of oil during the period 1948-1972.

The case of China's economy is another factor that influences the price of oil. In 2003, China became the global major consumer of oil according to the United States Energy Information Agency. The effect of increasing oil demand of China into the world economy has obviously influence the price of oil. China in our days has the slowest annual growth over more than a quarter century, which is frustrating, therefore the existence of uncertainty concerning the trend of China's economy considerably affects oil price in 2015[14].

The construction of a model for China by Fan *et al.*, (2007) shows that investment, consumption, income and trade adversely affected by the rising price of oil in the global economy. Also, Du *et al.*, (2010) show that China influenced by positive shocks to international oil prices with decreasing to the economic growth and increasing inflation.

Concerning the dynamic relationship between oil price and stock markets, Ewing and Thompson (2007) investigated the cyclical co-movements of crude oil price with other macroeconomic components. The authors concluded that that crude oil price is pro-cyclical, lags stock prices and leads consumer prices.

Moreover, Aloui and Jammazi (2009), developed a Markov switching model system to examine the relationship between the discharge of crude oil and Japanese, United Kingdom and French stock markets. The authors' findings suggest that increases in oil price have a substantial role in determining both the volatility of stock returns and probability of transition across regimes.

[12] https://en.wikipedia.org/wiki/Shale_oil_extraction
[13] www.oilprice.com/Energy
[14] http://www.eia.gov/

2.4 Oil Price Shocks to Macroeconomic Variables and Financial Markets

Oil price shocks happen after a certain change in demand and supply of that by extension is significantly associated with the uncertainty of economic policy. Examples of the changes in inflation, the oil production is explained by the crisis of political uncertainty is the 9/11 terrorist attack in the United States, the Asian crisis of 1997, but also the great recession of 2007-2008.

In particular, the period that followed the collapse of Lehman Brothers contributed to the upward trend of the volatility of political uncertainty disorders, given the company's size and its position as a major player in the United States and internationally[15].

In additional, Kilian (2009) and Hamilton (2009a, b) have proceeded with separation in demand and supply shocks in the crude oil market, as they gave great importance to the origin of the oil price shock. These authors highlighted that each of these shocks have different dynamic effects on the real price of crude oil.

Hamilton (2009a, b), disaggregates the oil price shocks to supply side oil price shocks and demand side oil price shocks. Also the author argued that demand-side oil price shocks deriving from industrialization of countries such as China could have a significant negative impact on stock prices due to the precautionary demand for crude oil, which illustrates the economic policy uncertainty about oil supply availability.

Kilian and Park (2009), proceeded to categorization of oil price shocks, since the fact that oil price shocks could affect stock markets due to the uncertainty which creates at the global economic environment, thus distinguishing the origin of the oil shocks in supply and demand, but by extension the demand into two parts[16].

1. Oil Demand Side Shocks:
    a. Aggregate Oil Demand Shocks.
    b. Precautionary Oil Demand Shocks or Oil Specific Demand Shocks.
2. Oil Supply Side Shocks.

Aggregate Oil Demand Shocks

Aggregate oil demand shocks referred to the demand which exists for crude oil and are undoubtable adapted to the fluctuations that exists the entire economic world. In general, the economic theory defines oil demand shock as a sudden event that increases or decreases demand for oil temporarily.

Especially, on the one hand, a positive oil demand shock increases the demand for oil and on the other hand, a negative demand shock for oil decreases the demand for oil. Oil demand shocks can originate from changes in variables such as tax rates, money supply and government spending[17]. In addition, a negative oil demand shock occurred during the global financial crisis of 2007-2009 in the United States economy led to increased uncertainty. Before the crisis, occurred a positive global oil demands side shock which led to international oversupply and rising inflationary pressures.

[15] http://www.investopedia.com/articles

[16] Authors that proceed to results by distinguishing the origin of the oil shocks, Baumeister and Peersman (2012), Basher *et al.*, (2012), Filis *et al.*, (2011), Kilian and Park (2009), Apergis and Miller (2009), Lescaroux and Mignon (2008) and Kilian (2008).

[17] http://www.investopedia.com/ask/answers/040215/what-are-common-examples-aggregate-demand-shocks.asp

Precautionary Oil Demand Shocks or Oil Specific Demand Shocks

The category of precautionary oil demand shock apparent from uncertainty about the deficiencies of the anticipated supply relative to expected economic market demand for oil is in general driven by shifts in the oil-specific demand for oil. Global economic circumstances and worldwide crude oil supply is the main driving force that moves precautionary oil demand shocks.

According to Alquist and Kilian (2010), oil-specific demand arises from the uncertainty about shortfalls of expected supply relative to expected demand. Moreover, shifts in uncertainty may arise, even by controlling the international business cycle and the worldwide supply of crude oil.

Oil Supply Side Shocks

Oil supply shocks reflect the current availability of natural inventories of crude oil. Thus, oil supply shock is an event that suddenly increases or decreases the supply of a crude oil which is traded internationally[18] and leads to uncertainty worldwide. This sudden change affects the equilibrium price of crude oil on the global economy for oil importing and oil exporting countries. A negative impact on the global economy was generated by oil supply shocks under Lippi and Nobili (2009). Respectively, Lescaroux and Mignon (2008) demonstrated that other reasons influences the volatility of oil price are the oil supply shocks.

Initially, as regards global economic activity, according to Ravazzolo and Vespignani (2015), Kilian's index of global real economic activity (REA), represents the global economy and predicts the worldwide GDP growth rates.

Especially, Kilian designed the REA index in 2009 using database of individual dry bulk shipping freight rates. Kilian's REA index became popular selection for the real economic activity worldwide as it captures business cycle fluctuations in global base about commodity markets of industrial sector and is used by many authors such as: Antonakakis *et al.*, (2014), Apergis and Miller (2009), Baumeister and Kilian (2013) and Alquist and Kilian (2010), among others.

Huge part of literature is based on these three shocks, oil demand side and supply side shocks, proposed by Kilian (2009). Especially, the study of Degiannakis *et al.*, (2014) examines daily data from both European stock market indices and European Industrial Sectors, as well as and monthly data for Brent crude oil at the same period. The authors provide evidence that oil price changes due to aggregate oil demand shocks, led to reduction in stock market volatility for all indices and all measures, whereas supply side shocks and oil specific demand shocks do not affect volatility.

Alquist *et al.*, (2011) found strong evidence consistent with economic theory, that the real price of oil after the 1973 population is predictable based on the fluctuations in the global real output. Hamilton (2009b), suggests that the shock of the oil price in 2007-2008, was caused by the demand of oil had risen to high levels, while the offer of world production was halted. Also, this disturbance in oil price was prior to the aggravation of consumer sentiment.

Apergis and Miller (2009) concluded that stock markets of oil-importing and oil-exporting economies do not response frequently to oil price shocks. According to

[18] https://en.wikipedia.org/wiki/Supply_shock

the International Energy Agency, the impact of high oil prices is a strong negative link to the international economy.

As mentioned to Bernanke *et al.*, (1997) and Blanchard and Gali (2007), oil price shocks are absorbed of the inflation stability which is followed by a range of countries worldwide, as a part of their monetary policy. The ability of oil price in predicting growth and inflation is shown by Stock and Watson (2003).

Park and Ratti (2008), concludes after investigation into sample compared with European countries that the positive shock in oil prices is favorable for oil exporting countries while the opposite happens with the oil importing countries. Similarly, Arouri and Rault (2012) argue that the contribution of oil price shocks is positive for stock market returns for the oil producing countries.

According to the approach of Filis *et al.*, (2011) on the one hand, the dynamic correlation between stock market prices and oil prices for oil exporting and oil importing countries, behaves similarly and especially positive due to aggregate demand shocks and negative due to precautionary demand shocks. On the other hand, supply side shocks do not seem to have an impact on relationship between the two markets.

The authors' findings conclude that lagged correlation results show that oil price exercise negative effect in all stock markets, regardless the origin of the oil price shock with only exception the 2008 global financial crisis. The aforementioned negative relationship of worldwide stock markets to oil shocks was also referred from Jones and Kaul (1996).

2.5 Oil Price Shocks and Uncertainty

Mostly in recent years has been the intensive attention of the literature on the contribution of economic policy uncertainty on real economic activity, which is a guide that affects the fluctuations in oil prices. An increase in the oil price in relation with the existence of uncertainty about the oil price fluctuations in the future have important affects the economic activity of the United States, as confirmed by, Elder and Serletis (2010), Lee, Ni and Ratti (1995) and Hamilton (1983).

Economic policy uncertainty indicates that the current state of the economic policy is such that the consequences or magnitude of circumstances are unpredictable. After the great recession of 2007-2008 and the shock suffered oil prices, uncertainty has increased dramatically, both in the degree of economic and political uncertainty and in the wider degree of political uncertainty in connection with the fiscal or monetary policy, the regulatory or tax regime and policy decisions worldwide[19]. As Hamilton (2009) expresses, a huge part of the recent recession in the United States may be justified by the shock of oil prices in 2007-2008.

Especially, economic policy uncertainty is another important factor in recent years participating in carrying out research concerning the price of oil but also crude oil market worldwide. More specifically, Baker *et al.*, (2013) have construct indices in order to capture economic policy uncertainty which receives more and more interest among researches and policy makers. Antonakakis *et al.*, (2014) reveal that aggregate demand oil price shocks have negative impact to economic policy uncertainty.

[19] https://en.wikipedia.org/wiki/Policy_uncertainty

Uncertainty's shocks that affect the macro economy have been explored by Baker *et al.*, (2013), through the use of the variation in global harmful events such as terrorist attacks and natural disasters among others. The factor of uncertainty on economic policy interacts with both the disorders occur in oil prices but moreover with stock prices.

Furthermore, there is a strong dependence between stock market volatility and oil prices as reported to Kang and Ratti (2015) from empirical evidence. Oil price volatility is another important factor of oil price with consequences to global economy, as discussed Hamilton (1983). Especially, on the one hand, oil production capacity does not shift fast and on the other hand oil consumers cannot quickly change their behavior, so this inelasticity means that a shock to the economic system can create volatility to the price of oil.

Interestingly, Sadorsky (1999), by using vector autoregressive models shows that oil price and oil price volatility are the main sources influencing the stock market returns, and particularly there are evidence that volatility of oil price shocks have asymmetric consequences for the economy. In addition, Efimova and Serletis (2014), Wang and Wu (2012), Chkili *et al.*, (2014) stress the importance of crude's oil volatility in energy markets. Bloom (2009) made an important contribution on the uncertainty and its connection with macroeconomic events as well finds that the uncertainty negatively impacts on the output growth and to its volatility.

In the first, a recent strand of the literature Bloom (2009), Kang and Ratti (2013a, b) and Antonakakis *et al.*, (2014), emphasize the role of economic policy uncertainty in the global economy and how drives oil price fluctuations. According to Bekiros *et al.*, (2015), economic policy uncertainty's information plays important role, especially for the nonlinear relation with the price of oil.

A few decades ago, authors like Bernanke (1983), Marcus (1981) and Rodrik (1991), had investigate the effects of economic policy uncertainty while after the financial crisis became more intensive research from Bloom (2009), Baum *et al.*, (2010) and Bachmann *et al.*, (2010).

Additionally, interest was focused more on the macroeconomic variables such as investment and output, which reflect an important part of the international economy. The general conclusion about the impact of economic policy uncertainty both in investment level and growth is negative, as reported by Jones and Olson (2013).

The important role of economic policy uncertainty in conjunction with the economic crisis and the global shocks was identified by Stock and Watson (2012). Also, Popescu and Smets (2010), focused on Germany and their main findings was that the uncertainty of crisis has temporary and limited impact on the economic action. In order to simulate the impact of disturbances on the overall uncertainty Bloom (2009) made use of a model based on data from the enterprise level. The conclusions of the author were that the effects of uncertainty were negative for higher production level.

In financial press, economic policy uncertainty influences the main macroeconomic variables such as investment, growth, inflation among others so the impact of the mentioned shifts is relative to the demand and the supply for crude oil. Seminal paper by Hamilton (1983), suggested that there is statistical significant correlation between oil shocks and recessions, through evidence over the period 1948-1972. Also, the author highlighted the dynamic relative effects of oil prices in the global economy.

Aloui *et al.*, (2015) conclude that the rising levels of economic policy uncertainty through the use of uncertainty indices, has important influence to the crude oil market returns for special periods such as the Great Depression of 2007-2008. Also, the authors results reveal that economic policy uncertainty shocks through aggregate demand oil price shocks will have a negative impact on economic policy uncertainty as well as causes oil price shocks.

Antonakakis *et al.*, (2014) conclude that timeless there is a systematically negative dynamic correlation between policy uncertainty and stock market returns with only exception the recent financial crisis. Reduction of stock market returns happens when there is an opposite situation in the economic policy uncertainty and in volatility of stock markets. In addition, two reasons which also affect economic policy uncertainty and the returns to stock market are the recessions which took place in the United States and the aggregate demand oil price shocks.

According to recent surveys, such as Colombo's (2013), economic policy uncertainty indices developed by Baker *et al.*, (2013), state that the increased uncertainty may affect the price of oil, more specifically increases oil price, which in turn pushes the oil producing countries to increase their production in order to supply the international oil market.

Therefore, shifts in oil prices can lead to oil supply and oil demand shocks. Bashar *et al.*, (2013), concludes that increase in uncertainty about oil prices will participate in decrease from the oil-producing countries, but also the deterioration of the prices at low levels. Consequently, there will be a negative oil demand shock to the world market.

In the short run, an economic negative oil supply shock will shift the aggregate oil supply curve leftward, decreasing the output and increasing the oil price level. In particularly, the imposition of an embargo on trade in oil would cause an adverse oil supply shock, since oil is a determinant factor of production for a wide variety of commodities. On the other side, an economic positive oil supply shock will shift the aggregate oil supply curve rightward, increasing output of oil and decreasing the oil price level. In additional, a positive oil supply shock promotes the production of oil and enhances the returns of crude oil market. Overall, supply side oil shocks influence the economic activity and cause economic policy uncertainty.

2.6 Measures of Uncertainty

There is a variety of economic indices for measuring uncertainty and include different perspectives of the global economic system. The analysis of Bernanke (1983) was among the first investigations noted that macroeconomic variables such as the shifts in the price of crude oil contribute the uncertainty associated with business investment and the whole economic system.

Policy makers and researchers are showing increased interest in the measures of economic policy uncertainty. In sphere of economic policy, the various types of uncertainty affect some fields more than others.

More specific, the economists Scott Baker, Nikolas Bloom and Steven Davis constructed indices in order to measure the economic policy uncertainty. Interestingly, these indices are the two following:

1. The Economic Policy Uncertainty Index.
2. The Equity Market Uncertainty Index.

The Economic Policy Uncertainty Index

Initially, the economic policy uncertainty index was constructed based on the data for the United States, but gradually evolved for other major world economies such as the European, Canadian, Chinese, Indian, Japanese, Dutch, Russian and South Korean.

The economic policy uncertainty index methodology is based on three underlying components[20]:

a. The first component quantifies newspaper articles derived from Google news search engine that contain key words relative with economic policy uncertainty. Notably, the first component of this index includes data searched in the file of the ten largest newspapers of the United States. In particular, the newspapers that participated in the aforementioned index are the following: The Chicago Tribune, USA Today, the newspaper Dallas Morning News, The Wall Street Journal, the Washington Post, the Boston Globe, the San Francisco Chronicle, the Miami Herald, the New York Times and the Los Angeles Times. Consequently, all these data collected in order to create a normalized index for the volume of the newspapers' articles for the uncertainty of economic policy.
b. The second component of the economic policy uncertainty index includes all the temporary provisions of the tax code expiration of the United States. In particular, is based on reports prepared by the Congressional Budget Office (CBO)[21]. The procedure in this component begins with the creation of annual number of provisions of the tax code which is weighted in dollars and provides a level of uncertainty about the future course of federal tax code.
c. Finally, the third component of the economic policy uncertainty index, consists of the factor of disagreement between the opinions of economic forecasters as an element of uncertainty. The information on this component of the index derive from the Federal Reserve Bank of Philadelphia's survey of professional forecasters. More in detail, the aforementioned process includes the dispersion that exists between the individual forecasters for levels of the consumer price index and the various expenditures for construction indicators of uncertainty.

In general, when values of the economic policy uncertainty index exceed 100, it means that the uncertainty is over the average, contrary to the values that are at lower level since 100.

The Equity Market Uncertainty Index

The equity market uncertainty index's methodology relies on an automated text-search process from Access World News's NewsBank service news articles that contain terms related to "uncertainty", "economy", "stock price" and "equity market". More specific, the attention of the Baker's *et al.*, analysis is utilizing a large range of United States newspapers, such as local and national newspapers. The mainly monthly

[20] http://www.policyuncertainty.com/methodology.html

[21] The Congressional Budget Office (CBO) is a federal agency that provides budgetary and economic issues in order to support the Congressional budget process.

data is collected from 1985 and then the normalization of the series of total articles related to the equity market uncertainty index is at an average value of 100.

In more recent literature, the aforementioned indicators of uncertainty are involved in exploring the relationship of economic policy uncertainty with the price of oil[22]. Notably, Antonakakis *et al.*, (2014) include the economic policy uncertainty index in order to examine the link between oil price and policy uncertainty. In addition, Bekiros *et al.*, (2015), examine the interrelationship between oil price returns and uncertainty in the economy with the use of the economic policy uncertainty index.

Another paper from Aloui *et al.*, (2015) highlights the dynamic impact of uncertainty to crude oil returns with economic policy uncertainty index as well as with equity market uncertainty index designed by Baker *et al.*, (2013). In addition, Kang and Ratti (2015), examine the dependency of China's policy uncertainty with the worldwide oil market returns also based on measures of economic policy uncertainty as economic policy uncertainty index.

The Chicago Board Options Exchange Volatility Index

Another measure that represents the uncertainty of stock market is the CBOE volatility index. In particular, the CBOE volatility index is quoted in percentage points and is calculated by the Chicago Board Options Exchange (CBOE)[23]. Consequently, the CBOE volatility index is a registered trademark of the CBOE[24].

Moreover, the CBOE volatility index is the leading measure of market expectations of the implied volatility of S&P 500 index (SPX)[25] options over the upcoming 30-day period[26]. Since 1993, the CBOE volatility index is computed on a real time-basis and has been regarded as a worldwide barometer of stock market volatility and investor sentiment.

In addition, the CBOE volatility index futures were introduced in 2004 and the CBOE volatility index options introduced in 2006 and both are available for investors in periods of pressure on the market in order to examine the use of instruments that provide the ability to diversify portfolios.

According to Baker *et al.*, (2013), the equity market uncertainty index and the CBOE volatility index demonstrate high co-movement. More specifically, Bloom (2009), incorporates the CBOE volatility index which has been proven as one of the key factors for investment decisions. Rossini (2013), examines the influences among stock market and economic policy uncertainty through the use of the CBOE volatility index. Instead of the CBOE volatility index, Aloui *et al.*, (2015) use the new based index of equity market uncertainty.

In more details, Antonakakis *et al.*, (2014) use the CBOE volatility index data series in order to explore the dynamic co-movements between stock market returns and policy uncertainty on the economy.

[22] Authors that include economic policy indices constructed by Baker *et al.*, are: Rossini (2013), Colombo (2013), Aastveit *et al.*, (2013), Balcilar *et al.*, (2015) and Sum (2013).

[23] Chicago Board Options Exchange is the worldwide largest options exchange and it focuses on options contracts and volatility trading through product innovation, technology and investor education.

[24] https://en.wikipedia.org/wiki/VIX

[25] The Standard & Poor's 500, is an American stock market index based on the market capitalizations of 500 leading companies publicly having common stock listed on the U.S. stock market.

[26] http://www.cboe.com/micro/vix/vixintro.aspx

The Purchasing Managers Index

Purchasing Managers index is an economic indicator derived from monthly surveys of two private sector companies: the institute for supply management (ISM) [27] and the Markit group. The maintaining of purchasing Managers index for the United States is by the institute for supply management. Interestingly, the purchasing Managers index is the leading indicator in the monthly institute for supply management report on business.

Especially, the purchasing Managers index is composite and contains five subsections. The components for the five sub-indices of purchasing Managers index are collected through surveys all over the United States, including more than 400 purchasing Managers which are chosen by geographic and industrial criteria[28].

The five sub-indices weighted to the purchasing Managers index as follows:

- Production level (25%).
- New orders (from customers) (30%).
- Supplier deliveries (15%).
- Inventories (10%).
- Employment level (20%).

In the strengths of purchasing Managers index is included that is a good predictor of futures releases such as growth domestic product and as for commodities, such as crude oil is reported individually regarding the tight supply and price levels of the previous month. The process of surveys is done by replying to the question about how the Managers see the industry, in three options: "better conditions", "same conditions", or "worse conditions".

Thus, the purchasing Managers index is calculated by the ratio of the Managers which answered positive in compare to the conditions of the previous month and subsequently this ratio is added to the total half of the percentage of respondents that replied "same conditions".

The range of purchasing Managers index is from 0 to 100. The ideal percentage of the purchasing Managers index is equivalent or above 50 which is generally indicates that the industry is expanding, so the global economy will be positively influenced and the uncertainty will decrease.

On the contrary, the purchasing Managers index below 50 percent means that the results "worse conditions" are physically not encouraging for the global economy and the uncertainty will be in higher levels. Consequently, the purchasing Managers index represents an important sentiment indicator for the international economic activity. More specific, the Federal Reserve System which is the central banking system of the United States considers the purchasing Managers index as a leading indicator.

Therefore, the indicator has a dual substance as to the objectivity of using data elements and as regards the subjectivity of taking the reply of those surveyed as respectively does the consumer confidence index.

[27] The Institute for Supply Management (ISM) founded in 1925, is a non-profit group and has mission is to lead in the supply management and purchasing professions.
[28] http://www.investopedia.com/university/releases/napm.asp

The Economic Sentiment Indicator

The economic sentiment indicator which is published every month by the European Commission (DG ECFIN[29]) is a composite indicator including five sub-indices of confidence with different weights in economic activity.

The five sub-indices that take into account the different components of the economy are the following[30]:

- Industrial confidence index.
- Services confidence index.
- Consumer confidence index.
- Construction confidence index.
- Retail trade confidence index.

The economic sentiment indicator is averaged with value 100 and the data is according the Statistical rating of financial activities in the European Union[31]. Especially, the economic sentiment indicator captures the estimations and prospects come from surveys related to economy members: consumers and producers. Also, these surveys allow comparisons about the business cycles between the countries.

Interestingly, the economic sentiment indicator is equivalent to the composite leading indicator of the United States. However, more in detail, the percentages held by each of the monthly sub-indices in the total economic sentiment indicator are:

- Industrial weights (40%).
- Services (30%).
- Consumers (20%).
- Construction (5%).
- Retail Trade (5%).

The economic sentiment indicator data is accurate and the information that provide monthly are exceptional about the economy of the European Union, which ranks first in inbound and outbound investments worldwide. Consequently, the economic sentiment indicator represents the economic performance of the economic activity and thus receives the tendency of uncertainty.

The Leading Economic Indicator

One category of economic indicators is leading indicators that change frequently prior to the changes in the economy. They are mainly short-term indicators and consist of individual parts that in total giving a comprehensive picture of economic activity[32]. Particularly, the leading economic indicators are designed to capture the troughs and peaks in the business cycle[33].

There are two types of leading indicators and specifically one type of index is designed by the OECD and the other type of index issued by the Conference Board[34].

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[29] The procedure Directorate General for Economic and Financial Affairs (DG ECFIN) is to conduct regular harmonized surveys for a range of alternative sector of the European Union's economy and the applicant countries

[30] http://ec.europa.eu/eurostat/en/web/products-datasets/-/TEIBS010

[31] http://www.indeepanalysis.gr/prodromes-ekselikseis-eyrwzwnh?tid=166

[32] https://en.wikipedia.org/wiki/Economic_indicator

[33] https://www.conference-board.org/data/bcicountry.cfm?cid=1

[34] Conference Board is a leading global provider of information and analytics around what consumers buy and watch, also is a non-profit business group that is highly regarded by investors and the Federal Reserve.

The Conference Board Leading Economic Index is designed to predict the future economic activity of United States and more specific about six to nine months ahead. In particularly, the leading economic index incorporates data from ten economic reports which are averaged, thus the index captures the volatility of the business cycle that is equalized with the value 100, in order to compare the level of the economic activity[35].

The Conference Board leading economic index for the United States consists of the ten individual components[36]:

a. The average weekly hours (manufacturing), which constitute the main sub-indicator for shifts in unemployment.
b. The average weekly jobless claims for unemployment insurance, that leads the monthly unemployment data released by the Department of Labor since is more influenced by the business activity.
c. The manufacturers' new orders for consumer goods/materials have central position, since for example the increase in orders for goods stresses that the economic activity is moving at a positive rate.
d. The vendor performance (slower deliveries diffusion index), measures the time required to become delivery of orders in industrial enterprises.
e. The manufacturers' new orders for non-defense capital goods, also leads the economic cycle, because increases in orders, means that it will be positive changes in actual production as well will increase demand.
f. The building permits for new housing units, is another main indicator since when adopt more and more building permits means that the construction sector in development, therefore the entire economy positively affected and the level of uncertainty is shrinking.
g. The Standard & Poor's 500 stock index incorporates the five hundred largest companies in the United States and constitutes a great measure as measuring stock price reflecting investor expectations and the future interest rate in the whole economy.
h. The money supply is an important indicator since if there is increasing demand deposits means that maybe the inflation will rise so will be reduced bank lending and will increase the savings as a result of uncertainty about the economy.
i. The interest rate spread is a 10-year Treasury vs. Federal Funds[37] target, therefore the changes in the yield curve (interest rate spread) usually predicts economic recession.
j. The index of consumer expectations is released once a month and is based primarily on surveys on consumer expectations for future economic activity.

The Organization for Economic Co-operation and Development Composite Leading Indicator is designed to provide the economic fluctuations and hence the economic policy uncertainty within the turning points in the business cycle. Specifically, the index is calculated for thirty-three countries members of OECD also for six non-members and eight inactive zones.

[35] http://www.investopedia.com/university/conferenceboard/conferenceboard2.asp
[36] http://www.investopedia.com/university/conferenceboard/conferenceboard2.asp
[37] Federal funds are excess reserves that commercial banks deposits at the regional Federal Reserve banks as well as helping commercial banks to meet the needs that have on a daily basis on their reserves. (http://www.investopedia.com)

The composition of the index includes a variety of individual indicators and gives mainly qualitative information on short-term movements in the overall economy[38]. Additionally, the composite leading indicator provides fluctuations of the business cycle about six months earlier and is published every month. The average weighted price of the index is the value 100 and when outgrow this value it means that the economy has momentum while below the value 100 means the opposite. In general, the composite leading indicator is a combination of individual economic indicators and of responses from surveys.

Overall, the leading economic indicators provide usefulness information since these indices predict the future fluctuation of the economy amidst an atmosphere of uncertainty.

The Misery Index

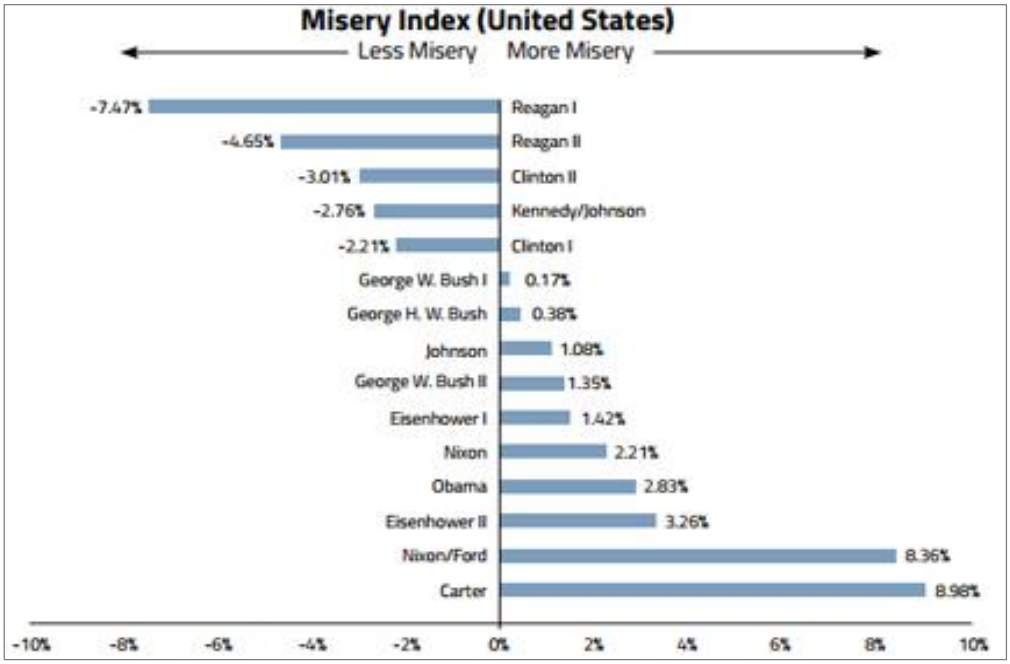
The original misery index created by distinguished economist Arthur Okun[39] is an indicator of economic prosperity in United States which is computed by taking of the total of unemployment rate with the inflation rate for specific period[40]. More specifically, the misery index determines how average citizens in United States cope with everyday life according to their economic situation. Consequently, the Misery index characterizes the current economic and social conditions in the United States. An extended version of Misery index with interest rates and gross domestic product trend, was created in late 2000s by Harvard Economist Robert Barro[41] in 1999 which is called Barro Misery index (BMI). Similarly, Steve Hanke[42] continued to develop BMI for more countries beyond the United States[43].

The first years of the Misery index implementation, observed that was at a very low comparative levels in the years that followed. The key affairs of the misery index is that the impact of the increase in inflation combined with the increase in the level of unemployment slows down the economic development of the United States, therefore has a negative impact by the economic slowdown and low consumer spending[44]. Historically, the peak of the misery index was in June 1980 (21.98%) and the trough in July 1953 (2.97%). At current period, in November 2015 the value of the Misery index is 5.5%[45].

Worldwide the order of the most miserable countries at the end of the year 2014 are the following: Venezuela, Argentina, Syria, Ukraine, and Iran. Respectively, the order of the least miserable countries are: Brunei, Switzerland, China, Taiwan, and Japan. In the sequel, Figure 5, presents time periods classified by the administration of Presidents, with the less and the more misery respectively, in the United States. Also, the United States ranks 95th of the 108 countries, thus is one of the least miserable nations in 2014[46].

[38] https://data.oecd.org/leadind/composite-leading-indicator-cli.htm#indicator-chart
[39] The economist Arthur Okun in the period of the administration of President Lyndon B. Johnson (1963-1968), served as President of the Council of Economic Advisers Chairman.
[40] http://inflationdata.com/articles/misery-index/
[41] Professor of Economics at Harvard University.
[42] Professor of Applied Economics at University in Baltimore.
[43] https://en.wikipedia.org/wiki/Misery_index_%28economics%29
[44] http://www.investopedia.com/terms/m/miseryindex.asp
[45] http://www.miseryindex.us/default.aspx
[46] http://www.cato.org/blog/world-misery-index-108-countries

Figure 5: *Misery Index Era by United States Presidents*



Source: *http://www.cato.org/publications/commentary/measuring-misery-around-world*

The Conditional Volatility of Crude Oil

Economic policy uncertainty which plays an important role in financial analysis is often measured by volatility. As regards, the conditional volatility of crude oil is a measure of uncertainty while quantifies the uncertainty about the future observation and is defined as the standard deviation of a conditional probability distribution and more specifically of crude oil returns. Especially, the conditional volatility of crude oil provides the latest information[47] and generally it is the best known measure of volatility.

In particular, the annualized monthly conditional volatility $CV_t^{(m)}$ is calculated as the square root of the total daily prices of conditional volatility, therefore the equation defined as:

$$CV_t^{(m)} = 100\sqrt{12\sum_{j=1}^{\tau}\sigma_{t_j}^2},$$

where, m consists the sampling frequency for j=1, …, N trading days of month t and $\sigma_{t_j}^2$ defines the daily conditional variance of crude oil.

The Realized Volatility of Crude Oil

The realized volatility of crude oil as a measure of uncertainty is defined as the standard deviation of intraday crude oil returns and estimates exactly what happened in the past under certain period[48]. Lastly, according to the literature the realized

[47] https://en.wikipedia.org/wiki/Conditional_variance
[48] http://www.nasdaq.com/investing/glossary/r/realized-volatility

volatility provides a relatively accurate measure of volatility. Therefore, the equation of the annualized realized volatility of month $RV_t^{(m)}$ is the following:

$$RV_t^{(m)} = 100\sqrt{12\sum_{j=1}^{\tau}\left(P_{t_j} - P_{t_{j-1}}\right)^2},$$

where, P_{t_j} consists of the log price of crude oil asset during j=1, …, N trading days of month t with sampling frequency m.

The Consumer Price Index

The consumer price index measures the average change over time in the price level purchased by households for consumer goods and services included in the "market basket[49]". Is one of the important economic indicators which is usually calculated monthly or quarterly and provides information in the economy, business and in Labor' Market.

Typically used by the government as a guide to decision makers. Also, the consumer price index is an economic statistical estimation which is constructed using the periodically prices of a sample of representative goods and services that consumers use on daily basis[50].

Especially the consumer price index is a combination of sub-indices that cover the consumer expenditures about different categories of goods and services which have their own weight to the household's total consumption. However, the annual percentage of the consumer price index is the benchmark inflation guide for the economy.

Moreover, the data of the consumer price index may display in many units of measurement focusing on the base year that is the value 100 is considered as mean value that a consumer could spend in order to acquire main goods and services annual[51]. In detail, the consumer price index is the most widely used measure of inflation as well as the percentage changes in the consumer price index from year to year over the period of the previous year expresses the annual inflation rate.

There are two categories of the consumer price index:

1. The Consumer Price Index in the United States.
2. The Harmonized Index of Consumer Prices for European Union Countries.

The Consumer Price Index in the United States is calculated every month by the United States Bureau of Labor Statistics (BLS)[52] which determines the average level of the index with reference base the period 1982-1984 that is equal to the value 100. Thus then the United States Bureau of Labor Statistics measures the changes compared to this value. The index concludes a set of consumer price indices that are aimed to capture different parts of the economic activity such as, urban consumers, urban wage earners and clerical workers[53].

[49] Market basket, is the type of basket of goods and services that offered to the consumer market and defines the consumer price index (CPI).
[50] https://en.wikipedia.org/wiki/Consumer_price_index
[51] https://www.bluenomics.com/glossary/consumer_price_index_cpi_all_items
[52] The Bureau of Labor Statistics (BLS) is principal governmental statistical unit of the department of labor and in general of the federal statistical system in the United States.
[53] https://en.wikipedia.org/wiki/United_States_Consumer_Price_Index

The Harmonized Index of Consumer Prices for European Union Countries is weighted mean of price indices for member countries that have adopted a common currency the euro, consequently is a measure of inflation[54]. The European central bank aims the price stability so is trying to maintain the percentage value of the index close to 2%.

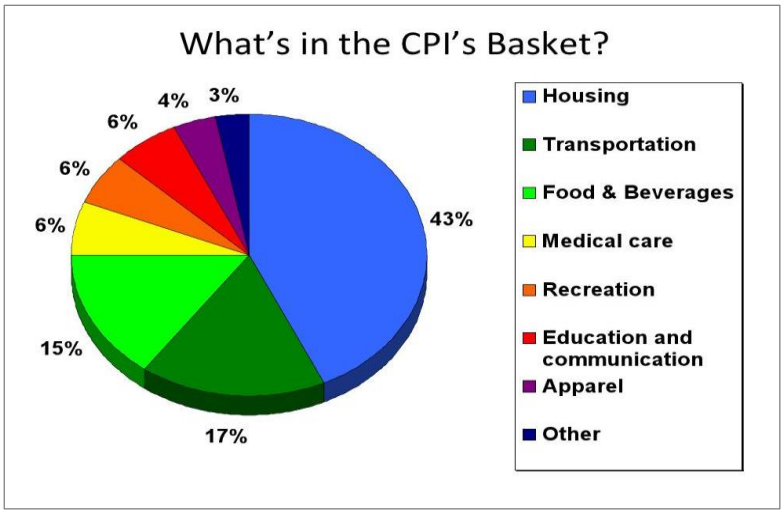
In comparison with the Consumer Price Index in the United States the aforementioned harmonized index incorporates rural and urban consumers and excludes the owner-occupied housing from the expenditures as it considers these as investment.

Furthermore, the main parts that each category follows are:

- Food and Beverages.
- Housing.
- Clothing.
- Transportation.
- Medical Care.
- Recreation.
- Education and Communication.
- Other Goods and Services (such as tobacco and smoking products and personal services among others).

Consequently, the consumer price index constitutes an important measure and through movement of the markets and the consumer climate provides a clear understanding of the economic activity in relation to the range of economic policy uncertainty. In the sequel, Figure 6, presents the main contents of Consumer Price Indicator's Basket.

Figure 6: *Main Contents of Consumer Price Indicator's (CPI's) Basket*



Source: *https://oliveramesmacrog.files.wordpress.com/2013/01/cpi-basket-chart.jpg*

The Consumer Confidence Index

The consumer confidence index is defined as an outstanding indicator which is designed to gauge every sector that is relative with the financial health, the purchasing

[54] https://en.wikipedia.org/wiki/Harmonised_Index_of_Consumer_Prices

power and the confidence of the average consumer in the economy. In particular, the consumer confidence index was first calculated in 1985 and is formed from survey results of more than 5000 households.

The subjective nature of consumer confidence index includes three subsectors:

a. The first refers to the consumer sentiment index, about how consumers feel on the current period.
b. The second is related with the current economic conditions, more specific about how the consumers feel for the performance of the economy.
c. The third is a consumer expectations index, about forecasts on the evolution of the economy in six months from the present period[55].

The value of the consumer confidence index is adjusted monthly with data which is available by age, income and region and is released from the Conference Board. Additionally, the opinion of the consumers about the current conditions includes the 40% of the consumer confidence index and the expectations of future conditions are make up the remaining 60%.

The consumer confidence index is average set at equal to 100, accordingly one the one hand the value above 100 indicates that prevails positive consumer sentiment and on the other hand when exceeds the value 100, then the confidence points are rising towards the higher consumer demand.

In case the consumer confidence index has downward trend means consumers have uncertainty about the economy as well as their future incomes, therefore spend less and less money in connection with the past, saving a larger share as well are not sure about taxes or prices that will have the commodities. However, when the report of the consumer confidence index is strong pushes the investors to purchase equities.

Generally, when increasing the level of consumer confidence indicator, there is a positive attitude on the broader economic activity with examples such as increase in retail sales, more consumption, more expenditures and low level of economic policy uncertainty. In conclusion, in periods of high uncertainty, the confidence of consumers fluctuates significantly while in periods of low uncertainty, the index of consumer confidence is following trend similar to that of the total economy[56].

The Chicago Fed National Activity Index

Another monthly index that is designed to cover the whole economic activity of the United States is Chicago Fed national activity index[57]. The current and future economic conditions but also the inflation, are recorded in this indicator, therefore the aforementioned index is associated with businesses as well as with inflationary cycles. Data of the Chicago Fed national activity index is monthly and this index is released at the end of each month on scheduled days.

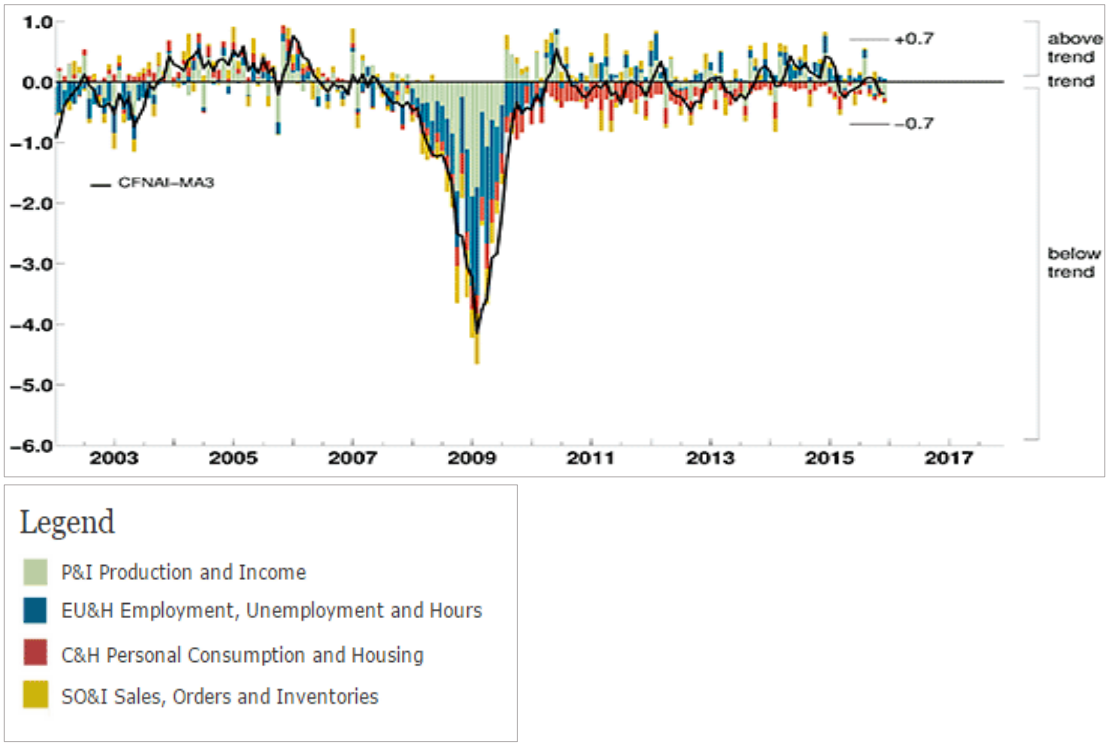
Specifically, the aforementioned index has been constructed as a weighted average of 85 indicators that measure several aspect of total macroeconomic activity, which fall into four major sections indicators that exist and cover the economic activity of the United States. The four broad categories of indicators including the 85 indicators of the overall economic activity of the United States are the following:

[55] http://www.investopedia.com/university/releases/consumerconfidence.asp
[56] https://en.wikipedia.org/wiki/Consumer_confidence_index
[57] More analytically, the CFNAI index is equivalent to that developed by James Stock of Harvard University at journal of Monetary Economics with title "Forecasting Inflation".

- The first category includes the P&I index of production and income, which includes 23 of the 85 indicators.
- The second category is composed by the EU&H indicator of the employment, unemployment and hours, which includes 24 of the 85 indicators.
- The third category of the broad index of the economy of the United States is the C&H index of personal consumption and housing, which includes 15 of the 85 indicators.
- Finally, the fourth category refers to the index SO&I of sales, orders and stocks, which includes 23 of the 85 indicators[58].

When the Chicago Fed national activity index has zero value and standard deviation with value one, denotes that the economy of the United States continues to trend growth according to historians recorded rhythms. In particular, on the one hand, when the values of the index have positive sign and are above the zero value illustrates that the speed of economic growth has speeded-up and has increased compared to the national average growth. On the other hand, when the values of the index is falling below the average growth that is below the zero value with a negative sign then indicates that has slowed and has decreased compared with the average development of the United States[59]. In the sequel, Figure 7, presents the Chicago Fed national activity index and the decomposition of the four elements of the data from 2002 until the current period.

Figure 7: *The Chicago Fed National Activity Index (CFNAI) and the Decomposition of the Four Elements of the Data from 2002 until the Current Period*



Source: *https://www.chicagofed.org/research/data/cfnai/current-data*

[58] http://www.mypivots.com/dictionary/definition/399/chicago-fed-national-activity-index-cfnai
[59] https://www.chicagofed.org/research/data/cfnai/historical-data

2.7 Modeling Oil Price

As Sims (1980) expresses, the structural vector autoregressive (Structural VAR) approach is designed specific to avoid difficulties carried out within simultaneous equation models which often tends to identifying restrictions. Structural VAR models usually treat all variables as endogenous[60].

In empirical economics, the analysis of disturbances in Structural VAR models is the closest approximation which is available. Blanchard και Quah (1989), were among the first to use the Structural VAR model to determine the long term effects of dynamic demand, but in combination with the supply disruptions. Therefore, the Structural VAR model is an essential tool for the analysis of fluctuations occurring in the economic system, both in terms of oil price and economic policy uncertainty.

In particular, regarding the Structural VAR model, Kang and Ratti (2013), use the Structural form of VAR model in order to investigate the disturbances in oil prices and their correlation with the economic policy uncertainty in the United States. In addition, Kang and Ratti (2015) through the use of the Structural VAR are considering the economy of China.

Moreover, the authors estimated that worldwide there are negative effects in oil prices due to the positive shock that happened in the economic policy uncertainty in China. Similarly, Bashar *et al.*, (2013) conclude through the use of the Structural VAR for Canada, that disturbances that occur in the price of oil do not affect the supply of this oil-producing country, but level of uncertainty that is created on the price of oil has impact on the whole of the country under consideration.

Another approach of the Structural VAR was made by Baker *et al.*, (2013), that use this model in conjunction with the indicators that the aforementioned authors created for economic policy uncertainty in order to examine the economic activity in the United States. Degiannakis *et al.*, (2014), conclude that oil price changes due to aggregate demand shocks that lead to reduction in stock market volatility for all indices and all measures, whereas supply side shocks and oil specific demand shocks do not affect volatility.

Baumeister and Kilian (2012), combining in real-time forecasts of the real price of oil, have shown the way that is possible to produce six basic forecast scenarios through the use of Structural VAR model. In the same way, Kilian (2009) consider a Structural VAR model and showed that models that contain endogenous oil prices should focus on the demand side of the crude oil market.

2.7.1 The Structural VAR Model

Kilian (2011) referred to Structural VAR econometric models as "…a multivariate, linear representation of a vector of observables on its own lags and (possibly) other variables as a trend or a constant." According to the existing literature, the p^{th} order Structural Vector Autoregressive model (Structural VAR) of N variables is written as:

[60] https://en.wikipedia.org/wiki/Vector_autoregression

$$\begin{bmatrix} \mathbf{1} & \cdots & \mathbf{A_{0:1,N}} \\ \vdots & \ddots & \vdots \\ \mathbf{A_{0:N,1}} & \cdots & \mathbf{1} \end{bmatrix} \begin{bmatrix} \mathbf{y_{1,t}} \\ \vdots \\ \mathbf{y_{N,t}} \end{bmatrix} = \begin{bmatrix} \mathbf{c_{0:1}} \\ \vdots \\ \mathbf{c_{0:N}} \end{bmatrix} + \begin{bmatrix} \mathbf{A_{1:1,1}} & \cdots & \mathbf{A_{1:1,k}} \\ \vdots & \ddots & \vdots \\ \mathbf{A_{1:N,1}} & \cdots & \mathbf{A_{1:N,N}} \end{bmatrix} \begin{bmatrix} \mathbf{y_{1,t-1}} \\ \vdots \\ \mathbf{y_{N,t-1}} \end{bmatrix} + \begin{bmatrix} \boldsymbol{\varepsilon}_{\mathbf{1,t}} \\ \vdots \\ \boldsymbol{\varepsilon}_{\mathbf{N.t}} \end{bmatrix}.$$

The representation of a p[th]-order Structural Vector Autoregressive model takes the following form:

$$\mathbf{A_0}\, \mathbf{y_t} = \mathbf{c_0} + \mathbf{A_i y_{t-1}} + \ldots + \mathbf{A_i y_{t-i}} + \boldsymbol{\varepsilon}_\mathbf{t}. \qquad (1)$$

In addition, the general form of a p[th]-order Structural Vector Autoregressive model is expressed as:

$$\mathbf{A_0}\, \mathbf{y_t} = \mathbf{c_0} + \sum_{\mathbf{i=1}}^{\mathbf{p}} \mathbf{A_i}\, \mathbf{y_{t-i}} + \boldsymbol{\varepsilon}_\mathbf{t}, \qquad (2)$$
$$\boldsymbol{\varepsilon}_\mathbf{t} \sim \mathbf{iid\ N(0, D)},$$

where, $\mathbf{A_0}$ represents the [N × N] matrix that summarizes the contemporaneous relationship between the variables of the model and is normalized to have ones on the main diagonal terms, the time index is t=1, …, T, the variable index is n=1, …, N, $\mathbf{y_t}$ is a [N × 1] vector of N endogenous variables, $\mathbf{c_0}$ is a [N × 1] vector of constants, $\mathbf{A_i}$ are [N × N] autoregressive coefficient matrices: for every i=1, …, p and $\boldsymbol{\varepsilon}_\mathbf{t}$ is a [N × 1] vector of error terms "*structural shocks*" assumed to have zero covariance and be serially uncorrelated, $\mathbf{E(\varepsilon_t) = 0}$, $\mathbf{E(\varepsilon_t \varepsilon'_t) = D}$ and $\mathbf{E(\varepsilon_t \varepsilon'_{t-N}) = 0}$.

Equivalently, model (2) can be written more compactly as:

$$\mathbf{A(L)y_t = \varepsilon_t}, \qquad (3)$$

where, **A(L)** is the p[th] order matrix polynomial in the lag operator L and is written as:

$$\mathbf{A(L) \equiv A_0 - A_1 L - A_2 L - \ldots - A_i L^i}. \qquad (4)$$

The variance-covariance matrix of the structural shocks where all the elements off the main diagonal are zero is typically normalized that:

$$\mathbf{E}[\boldsymbol{\varepsilon}_\mathbf{t} \boldsymbol{\varepsilon}'_\mathbf{t}] = \mathbf{D} = \begin{bmatrix} \boldsymbol{\sigma}_\mathbf{1}^\mathbf{2} & \mathbf{0} & \mathbf{0} & \ldots & \mathbf{0} \\ \mathbf{0} & \boldsymbol{\sigma}_\mathbf{2}^\mathbf{2} & \mathbf{0} & \ldots & \mathbf{0} \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ \mathbf{0} & \mathbf{0} & \mathbf{0} & \ddots & \boldsymbol{\sigma}_\mathbf{i}^\mathbf{2} \end{bmatrix}.$$

In order to get the reduce form of our Structural VAR model **(1)** we multiply both sides with, such $\mathbf{A_0^{-1}}$ as that:

$$\mathbf{A_0^{-1}\, A_0\ y_t} = \mathbf{A_0^{-1} c_0} + \mathbf{A_0^{-1} A_i y_{t-1}} + \ldots + \mathbf{A_0^{-1} A_i y_{t-i}} + \mathbf{A_0^{-1}}\, \boldsymbol{\varepsilon}_\mathbf{t}. \qquad (5)$$

Also, equivalently the reduced Structural VAR model **(5)** can be written more compactly as:

$$\mathbf{B(L)y_t = e_t,} \qquad \mathbf{(6)}$$

where, **B(L)** is the p^{th} order matrix polynomial in the lag operator L and is written as:

$$\mathbf{B(L) \equiv A_0^{-1}A(L) = I - B_1L - B_1L^2 - \dots - B_iL^i.} \qquad \mathbf{(7)}$$

Hence, the reduced form Structural VAR model **(5)** can be represented as:

$$\mathbf{y_t = a_0 + B_iy_{t-1} + \dots + B_iy_{t-i} + e_t.} \qquad \mathbf{(8)}$$

Especially, the more gathered representation of the reduced form Structural VAR model is,

$$\mathbf{y_t = a_0 + \sum_{i=1}^{p} B_i\, y_{t-i} + e_t,} \qquad \mathbf{(9)}$$
$$\mathbf{e_t \sim iid\ N(0, \Sigma)},$$

where, $\mathbf{a_0 = A_0^{-1}c_0}$, $\mathbf{B_i = A_0^{-1}A_i}$ and $\mathbf{e_t = A_0^{-1}\,\varepsilon_t}$, i.e. $\mathbf{\varepsilon_t = A_0\ e_t}$. The reduced-form errors $\mathbf{e_t}$ are linear combinations of the structural errors $\boldsymbol{\varepsilon_t}$, with a covariance matrix of the form can be expressed as:

$$\mathbf{E[e_te'_t] = \Sigma = A_0^{-1}\,D\,A_0^{-1\prime}.}$$

The structural shocks can be derived by imposing suitable restrictions on. The $\mathbf{A_0^{-1}}$ short-run restrictions are imposed in the following model:

$$\begin{bmatrix} \mathbf{e_{1,t}} \\ \vdots \\ \mathbf{e_{N,t}} \end{bmatrix} = \begin{bmatrix} \mathbf{a_{1,1}} & \mathbf{0} & \mathbf{0} \\ \vdots & \ddots & \mathbf{0} \\ \mathbf{a_{N,1}} & \dots & \mathbf{a_{N,N}} \end{bmatrix} \times \begin{bmatrix} \boldsymbol{\varepsilon_{1,t}} \\ \vdots \\ \boldsymbol{\varepsilon_{N,t}} \end{bmatrix}.$$

Chapter 3

Methodology and Data

3.1 Model Description

In this section a vector autoregressive analysis is employed to explore the impulse responses of oil price shocks to the respective uncertainty indices. More specifically, the Structural VAR model informs about whether the relevant indicator of uncertainty provides information or not for oil price shocks.

In particular, the Structural VAR model is presented and includes three types of oil price shocks as these are distinguish by Kilian and Park (2009) and ten measures of uncertainty.

Namely, the three oil price shocks are the following:

- Oil Supply Side Shocks (SS), which specifically reflect Changes in World Oil Production of Crude Oil (DPROD).
- As well as, two types of oil demand side shocks:
  i. The Aggregate Oil Demand Shocks (ADS), which are identified from global real economic activity and notably from Kilian's Real Economic Activity Index (REA).
  ii. Precautionary Oil Demand Shocks or Oil Specific Demand Shocks (OSS) that are identified from changes in Brent Crude Oil Prices (DOP).

The Economic Policy Uncertainty Shocks (EPS), are identified from the following ten uncertainty measures: the DCCI which is identified from the first differences of Consumer Confidence Indicator, the CFNAI of Chicago Fed National Activity Index, the DCPI that reflects the changes in Consumer Price Index, the CV Index of Conditional Volatility of Crude Oil , the EMU Index of Equity Market Uncertainty, the EPU Index of Economic Policy Uncertainty, the DMISERY that represents the changes in Misery Index, the PMI of Purchasing Managers Index, the RV Index of Realized Volatility of Crude Oil and the VIX of Chicago Board Options Exchange Volatility Index. The uncertainty indices chosen are those dealing with the broader section on economic activity in the United States.

UNCERT is the generic name of uncertainty series. For each Structural VAR model the uncertainty variable will be named with the corresponding name of the uncertainty index that will be used.

The standard representation of a general p^{th}-order Structural VAR model expresses as the following form:

$$\mathbf{A_0}\,\mathbf{y_t} = \mathbf{c_0} + \sum_{\mathbf{i=1}}^{\mathbf{p}} \mathbf{A_i}\,\mathbf{y_{t-i}} + \boldsymbol{\varepsilon_t}, \qquad \mathbf{(1)}$$
$$\boldsymbol{\varepsilon_t} \sim \mathbf{iid}\ \mathbf{N}(\mathbf{0}, \mathbf{D}),$$

where, $\mathbf{A_0}$ represents the $[4 \times 4]$ matrix that summarizes the contemporaneous relationship between the variables of the model and is normalized to have ones on the main diagonal terms, the time index is t=1, …, T, the variable index is n=1, …, 4, $\mathbf{c_0}$ is a $[4 \times 1]$ vector of constants, $\mathbf{A_i}$ are $[4 \times 4]$ autoregressive coefficient matrices:

for every i=1, …, p and $\boldsymbol{\varepsilon_t}$ is a $[4 \times 1]$ vector of error terms "*structural shocks*" assumed to have zero covariance and be serially uncorrelated, $\mathbf{E(\varepsilon_t) = 0}$, $\mathbf{E(\varepsilon_t \varepsilon'_t) = D}$ and $\mathbf{E(\varepsilon_t \varepsilon'_{t-N}) = 0}$.

In addition, $\mathbf{y_t}$ is a $[4 \times 1]$ vector of 4 endogenous variables and specifically:

$$\mathbf{y_t} = [\mathbf{DPROD_t}, \mathbf{REA_t}, \mathbf{DOP_t}, \mathbf{UNCERT_t}],$$

As well as, for each of the ten indicators of uncertainty takes the following form:

1. $\mathbf{y_t} = [\mathbf{DPROD_t}, \mathbf{REA_t}, \mathbf{DOP_t}, \mathbf{DCCI_t}]$
2. $\mathbf{y_t} = [\mathbf{DPROD_t}, \mathbf{REA_t}, \mathbf{DOP_t}, \mathbf{CFNAI_t}]$
3. $\mathbf{y_t} = [\mathbf{DPROD_t}, \mathbf{REA_t}, \mathbf{DOP_t}, \mathbf{DCPI_t}]$
4. $\mathbf{y_t} = [\mathbf{DPROD_t}, \mathbf{REA_t}, \mathbf{DOP_t}, \mathbf{CV_t}]$
5. $\mathbf{y_t} = [\mathbf{DPROD_t}, \mathbf{REA_t}, \mathbf{DOP_t}, \mathbf{EMU_t}]$
6. $\mathbf{y_t} = [\mathbf{DPROD_t}, \mathbf{REA_t}, \mathbf{DOP_t}, \mathbf{EPU_t}]$
7. $\mathbf{y_t} = [\mathbf{DPROD_t}, \mathbf{REA_t}, \mathbf{DOP_t}, \mathbf{DMISERY_t}]$
8. $\mathbf{y_t} = [\mathbf{DPROD_t}, \mathbf{REA_t}, \mathbf{DOP_t}, \mathbf{PMI_t}]$
9. $\mathbf{y_t} = [\mathbf{DPROD_t}, \mathbf{REA_t}, \mathbf{DOP_t}, \mathbf{RV_t}]$
10. $\mathbf{y_t} = [\mathbf{DPROD_t}, \mathbf{REA_t}, \mathbf{DOP_t}, \mathbf{VIX_t}]$

The variance-covariance matrix of the structural shocks where all the elements off the main diagonal are zero is typically normalized that:

$$\mathbf{E}[\boldsymbol{\varepsilon_t}\boldsymbol{\varepsilon'_t}] = \mathbf{D} = \begin{bmatrix} \boldsymbol{\sigma_1^2} & \mathbf{0} & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \boldsymbol{\sigma_2^2} & \mathbf{0} & \mathbf{0} \\ \vdots & \vdots & \boldsymbol{\sigma_3^2} & \vdots \\ \mathbf{0} & \mathbf{0} & \mathbf{0} & \boldsymbol{\sigma_4^2} \end{bmatrix}.$$

In order to get the reduce form of our structural model **(1)** we multiply both sides with, such $\mathbf{A_0^{-1}}$ as that:

$$\mathbf{y_t} = \mathbf{a_0} + \sum_{\mathbf{i=1}}^{\mathbf{p}} \mathbf{B_i}\, \mathbf{y_{t-i}} + \mathbf{e_t}, \qquad \mathbf{(2)}$$
$$\mathbf{e_t} \sim \mathbf{iid}\ \mathbf{N(0, \Sigma)},$$

where, $\mathbf{a_0} = \mathbf{A_0^{-1}c_0}$, $\mathbf{B_i} = \mathbf{A_0^{-1}A_i}$ and $\mathbf{e_t} = \mathbf{A_0^{-1}}\ \boldsymbol{\varepsilon_t}$, i.e. $\boldsymbol{\varepsilon_t} = \mathbf{A_0}\ \mathbf{e_t}$. The reduced-form errors $\mathbf{e_t}$ are linear combinations of the structural errors $\boldsymbol{\varepsilon_t}$, with a covariance matrix of the form can be expressed as:

$$\mathbf{E}[\mathbf{e_t}\mathbf{e'_t}] = \mathbf{\Sigma} = \mathbf{A_0^{-1}}\ \mathbf{D}\ \mathbf{A_0^{-1\prime}}.$$

The structural shocks (or disturbances) can be derived by imposing suitable restrictions on. The $\mathbf{A_0^{-1}}$ following short-run restrictions are imposed in the model:

$$\begin{bmatrix} e_{1,t}^{DPROD} \\ e_{2,t}^{REA} \\ e_{3,t}^{DOP} \\ e_{4,t}^{UNCERT} \end{bmatrix} = \begin{bmatrix} a_{1,1} & 0 & 0 & 0 \\ a_{2,1} & a_{2,2} & 0 & 0 \\ a_{3,1} & a_{3,2} & a_{3,3} & 0 \\ a_{4,1} & a_{4,2} & a_{4,3} & a_{4,4} \end{bmatrix} \times \begin{bmatrix} \varepsilon_{1,t}^{SS} \\ \varepsilon_{2,t}^{ADS} \\ \varepsilon_{3,t}^{OSS} \\ \varepsilon_{4,t}^{EPS} \end{bmatrix}.$$

In which $e_{1,t}^{DPROD}$ captures the supply side shocks of oil, $e_{2,t}^{REA}$ reflects the aggregate demand shocks, $e_{3,t}^{DOP}$ denotes the precautionary oil demand shocks and $e_{4,t}^{UNCERT}$ measures the uncertainty shocks.

In more detail the ten Structural VAR models under examination are presented below:

1. $$\begin{bmatrix} e_{1,t}^{DPROD} \\ e_{2,t}^{REA} \\ e_{3,t}^{DOP} \\ e_{4,t}^{DCCI} \end{bmatrix} = \begin{bmatrix} a_{1,1} & 0 & 0 & 0 \\ a_{2,1} & a_{2,2} & 0 & 0 \\ a_{3,1} & a_{3,2} & a_{3,3} & 0 \\ a_{4,1} & a_{4,2} & a_{4,3} & a_{4,4} \end{bmatrix} \times \begin{bmatrix} \varepsilon_{1,t}^{SS} \\ \varepsilon_{2,t}^{ADS} \\ \varepsilon_{3,t}^{OSS} \\ \varepsilon_{4,t}^{EPS} \end{bmatrix}.$$

2. $$\begin{bmatrix} e_{1,t}^{DPROD} \\ e_{2,t}^{REA} \\ e_{3,t}^{DOP} \\ e_{4,t}^{CFNAI} \end{bmatrix} = \begin{bmatrix} a_{1,1} & 0 & 0 & 0 \\ a_{2,1} & a_{2,2} & 0 & 0 \\ a_{3,1} & a_{3,2} & a_{3,3} & 0 \\ a_{4,1} & a_{4,2} & a_{4,3} & a_{4,4} \end{bmatrix} \times \begin{bmatrix} \varepsilon_{1,t}^{SS} \\ \varepsilon_{2,t}^{ADS} \\ \varepsilon_{3,t}^{OSS} \\ \varepsilon_{4,t}^{EPS} \end{bmatrix}.$$

3. $$\begin{bmatrix} e_{1,t}^{DPROD} \\ e_{2,t}^{REA} \\ e_{3,t}^{DOP} \\ e_{4,t}^{DCPI} \end{bmatrix} = \begin{bmatrix} a_{1,1} & 0 & 0 & 0 \\ a_{2,1} & a_{2,2} & 0 & 0 \\ a_{3,1} & a_{3,2} & a_{3,3} & 0 \\ a_{4,1} & a_{4,2} & a_{4,3} & a_{4,4} \end{bmatrix} \times \begin{bmatrix} \varepsilon_{1,t}^{SS} \\ \varepsilon_{2,t}^{ADS} \\ \varepsilon_{3,t}^{OSS} \\ \varepsilon_{4,t}^{EPS} \end{bmatrix}.$$

4. $$\begin{bmatrix} e_{1,t}^{DPROD} \\ e_{2,t}^{REA} \\ e_{3,t}^{DOP} \\ e_{4,t}^{CV} \end{bmatrix} = \begin{bmatrix} a_{1,1} & 0 & 0 & 0 \\ a_{2,1} & a_{2,2} & 0 & 0 \\ a_{3,1} & a_{3,2} & a_{3,3} & 0 \\ a_{4,1} & a_{4,2} & a_{4,3} & a_{4,4} \end{bmatrix} \times \begin{bmatrix} \varepsilon_{1,t}^{SS} \\ \varepsilon_{2,t}^{ADS} \\ \varepsilon_{3,t}^{OSS} \\ \varepsilon_{4,t}^{EPS} \end{bmatrix}.$$

5. $$\begin{bmatrix} e_{1,t}^{DPROD} \\ e_{2,t}^{REA} \\ e_{3,t}^{DOP} \\ e_{4,t}^{EMU} \end{bmatrix} = \begin{bmatrix} a_{1,1} & 0 & 0 & 0 \\ a_{2,1} & a_{2,2} & 0 & 0 \\ a_{3,1} & a_{3,2} & a_{3,3} & 0 \\ a_{4,1} & a_{4,2} & a_{4,3} & a_{4,4} \end{bmatrix} \times \begin{bmatrix} \varepsilon_{1,t}^{SS} \\ \varepsilon_{2,t}^{ADS} \\ \varepsilon_{3,t}^{OSS} \\ \varepsilon_{4,t}^{EPS} \end{bmatrix}.$$

6.
$$\begin{bmatrix} e_{1,t}^{DPROD} \\ e_{2,t}^{REA} \\ e_{3,t}^{DOP} \\ e_{4,t}^{EPU} \end{bmatrix} = \begin{bmatrix} a_{1,1} & 0 & 0 & 0 \\ a_{2,1} & a_{2,2} & 0 & 0 \\ a_{3,1} & a_{3,2} & a_{3,3} & 0 \\ a_{4,1} & a_{4,2} & a_{4,3} & a_{4,4} \end{bmatrix} \times \begin{bmatrix} \varepsilon_{1,t}^{SS} \\ \varepsilon_{2,t}^{ADS} \\ \varepsilon_{3,t}^{OSS} \\ \varepsilon_{4,t}^{EPS} \end{bmatrix}.$$

7.
$$\begin{bmatrix} e_{1,t}^{DPROD} \\ e_{2,t}^{REA} \\ e_{3,t}^{DOP} \\ e_{4,t}^{DMISERY} \end{bmatrix} = \begin{bmatrix} a_{1,1} & 0 & 0 & 0 \\ a_{2,1} & a_{2,2} & 0 & 0 \\ a_{3,1} & a_{3,2} & a_{3,3} & 0 \\ a_{4,1} & a_{4,2} & a_{4,3} & a_{4,4} \end{bmatrix} \times \begin{bmatrix} \varepsilon_{1,t}^{SS} \\ \varepsilon_{2,t}^{ADS} \\ \varepsilon_{3,t}^{OSS} \\ \varepsilon_{4,t}^{EPS} \end{bmatrix}.$$

8.
$$\begin{bmatrix} e_{1,t}^{DPROD} \\ e_{2,t}^{REA} \\ e_{3,t}^{DOP} \\ e_{4,t}^{PMI} \end{bmatrix} = \begin{bmatrix} a_{1,1} & 0 & 0 & 0 \\ a_{2,1} & a_{2,2} & 0 & 0 \\ a_{3,1} & a_{3,2} & a_{3,3} & 0 \\ a_{4,1} & a_{4,2} & a_{4,3} & a_{4,4} \end{bmatrix} \times \begin{bmatrix} \varepsilon_{1,t}^{SS} \\ \varepsilon_{2,t}^{ADS} \\ \varepsilon_{3,t}^{OSS} \\ \varepsilon_{4,t}^{EPS} \end{bmatrix}.$$

9.
$$\begin{bmatrix} e_{1,t}^{DPROD} \\ e_{2,t}^{REA} \\ e_{3,t}^{DOP} \\ e_{4,t}^{RV} \end{bmatrix} = \begin{bmatrix} a_{1,1} & 0 & 0 & 0 \\ a_{2,1} & a_{2,2} & 0 & 0 \\ a_{3,1} & a_{3,2} & a_{3,3} & 0 \\ a_{4,1} & a_{4,2} & a_{4,3} & a_{4,4} \end{bmatrix} \times \begin{bmatrix} \varepsilon_{1,t}^{SS} \\ \varepsilon_{2,t}^{ADS} \\ \varepsilon_{3,t}^{OSS} \\ \varepsilon_{4,t}^{EPS} \end{bmatrix}.$$

10.
$$\begin{bmatrix} e_{1,t}^{DPROD} \\ e_{2,t}^{REA} \\ e_{3,t}^{DOP} \\ e_{4,t}^{VIX} \end{bmatrix} = \begin{bmatrix} a_{1,1} & 0 & 0 & 0 \\ a_{2,1} & a_{2,2} & 0 & 0 \\ a_{3,1} & a_{3,2} & a_{3,3} & 0 \\ a_{4,1} & a_{4,2} & a_{4,3} & a_{4,4} \end{bmatrix} \times \begin{bmatrix} \varepsilon_{1,t}^{SS} \\ \varepsilon_{2,t}^{ADS} \\ \varepsilon_{3,t}^{OSS} \\ \varepsilon_{4,t}^{EPS} \end{bmatrix}.$$

The short-term restrictions which are necessary in the context of structural VAR models as well identify the three oil price shocks, egged of Kilian and Park (2009), are explained as follows.

Starting with the global oil production under the existing literature, there is not simultaneously response to the innovations in the demand for crude oil in the same month, especially in oil-producing countries. However, it requires time for the oil production costs to adapt to new conditions. On the other hand, the disturbances in the world oil production directly impact both on oil prices as much and in the global real economic activity.

Additionally, it is worth noting that changes in oil prices does not affect directly in the global real economic activity while the opposite occurs from the side of the changes in global real economic activity which has immediate impact on oil prices. Consequently, oil prices are those responding directly following the aforementioned oil price shocks. Therefore, disturbances of worldwide oil production usually influence the uncertainty directly or are causing insignificant impact. Characteristics, an unexpected positive supply side shock, defined as unpredictable innovations to world oil production, increases the world oil production, increases the

global real economic activity and decreases or does not cause effect in oil price. Consequently, the news from financial markets is positive and in general the oil supply shock has negative effect on uncertainty, or maybe is not evaluated and thus the uncertainty is not influenced.

Thereafter, the literature reports[61] that an unexpected positive aggregate oil demand shock affects global production, the international real economic activities and thus leads to high crude oil prices. So, the news from the crude oil markets are positive and the positive aggregate oil demand shock usually reduces uncertainty. In conclusion, the aggregate demand shock is expected to have negative effect on the uncertainty.

Consecutively, the precautionary oil demand is driven by the sense of uncertainty as regards the future oil supply shortfalls. Moreover, the positive precautionary oil demand shock increase world oil production, causes fall in the global real economic activity and as a consequence, increases the price of crude oil. However, the financial market news are negative after such a disturbance so the uncertainty increases. Hence, the relationship between the uncertainty and the precautionary oil demand shocks, is positive.

Accordingly, the ten under examination uncertainty indices are expected to have a corresponding responses to the three aforementioned oil price shocks.

The following indicators of uncertainty: Consumer Confidence Indicator, Chicago Fed National Activity Index, Purchasing Managers Index and Misery Index, have not been implemented in the existing literature and therefore expected to react rationally to oil price shocks. Hence, the oil supply shocks are expected to have either a positive or insignificant effect on Consumer Confidence Indicator, Chicago Fed National Activity Index and Purchasing Managers Index while respectively negative effect on Misery Index.

In particular, the following measures of uncertainty: Consumer Confidence Indicator, Chicago Fed National Activity Index and Purchasing Managers Index, are expected to have positive reaction to aggregate demand shocks and the Misery Index has opposite reactions. Specifically, the uncertainty measures above respond differently to shocks of preventative oil demand. Hence, the indicators: Consumer Confidence Indicator, Chicago Fed National Activity Index and Purchasing Managers Index after such a shock are expected to have downward trend because exists sense of heightened uncertainty in the financial world. Instead, the Misery Index is expected to have same trend with uncertainty.

Subsequently, the literature mentions the expected reactions of the following indices: Consumer Price Index[62], Conditional Volatility of Crude Oil, Equity Market Uncertainty Index, Economic Policy Uncertainty Index[63], Realized Volatility of Crude

[61] See Kilian and Park (2009), Hooker (2002), Kilian (2009), Hamilton (2009a, b), Degiannakis *et al.*, (2014), Aloui *et al.*, (2015), Antonakakis *et al.*, (2014), Alquist and Kilian (2010) and Stock and Watson (2012), among many investigations.

[62] Indicative literature which include evidence about the inflation: Natal (2012), Montoro (2012), Malliaris and Malliaris (2013), Filis and Chatziantoniou (2013) and Balke *et al.*, (2010).

[63] Existing literature which include evidence about the policy uncertainty indices constructed by Baker, *et al.*, (2013): Rossini (2013), Colombo (2013), Aastveit *et al.*, (2013), Balcilar *et al.*, (2015), Bekiros *et al.*, (2015), Kang and Ronald (2015), Antonakakis *et al.*, (2014), Karnizova and Li (2014) and Sum (2013) among others.

Oil and Implied Volatility Index of S&P 500[64]. These indicators are expected to have negative or insignificant impact on oil supply shocks and often behave similar to the variation of the uncertainty in the financial world. Regarding these indicators of uncertainty, have opposite reactions to aggregate demand shocks and when the conditions in economic activity are better, are reduced. In particular, the aforementioned uncertainty measures are expected to have same trend with uncertainty, so are increased when precautionary oil demand shock occur.

3.2 Data Description

In this dissertation, the monthly data used are:

- The Changes in World Oil Production in Thousand Barrels (DPROD).
- Global Real Economic Activity Index by Lutz Kilian (REA).
- The Changes in Brent Crude Oil Prices as a Proxy for Oil Prices (DOP).
- Measures of Uncertainty.

  Especially, in detail are used the following ten measures of uncertainty:

  1. The Consumer Confidence Indicator (DCCI).
  2. The Chicago Fed National Activity Index (CFNAI).
  3. The Consumer Price Index (DCPI).
  4. The Conditional Volatility of Crude Oil (CV).
  5. The Equity Market Uncertainty Index (EMU).
  6. The Economic Policy Uncertainty Index (EPU).
  7. The Misery Index (DMISERY).
  8. The Purchasing Managers Index (PMI).
  9. The Realized Volatility of Crude Oil (RV).
  10. The Implied Volatility Index of S&P 500 (VIX).

All data are spanning from January 1994 to March 2015 for the economy of United States and summarize 255 observations, with only exception the Realized Volatility of crude oil that represents sample from August 2003 to March 2015 and summarizes 140 observations following the unavailability of data.

The transformations of the imported data series in the tested sample are the following:

a. The Global Real Economic Activity Index, the Consumer Confidence Indicator, the Equity Market Uncertainty Index, the Economic Policy Uncertainty Index, the Purchasing Managers Index, the Realized Volatility of Crude Oil and the Implied Volatility Index of S&P 500, are divided by 100 and the data is converted into decimals in order to be comparable and in details, the Consumer Confidence Indicator is converted into first differences in order to be stationary series.
b. Also, the Brent Crude Oil Prices, the World Oil Production, the Consumer Price Index and the Misery Index, are expressed in logarithmic differentiation as well they include differences of the prices, according to the literature.

[64] Existing literature which include evidence about the volatility indices: Aloui *et al.*, (2015), Jones and Kaul (1996), Park and Ratti (2008), Degiannakis *et al.*, (2014), Bloom (2009), Filis *et al.*, (2011), Antonakakis *et al.*, (2014) and Zhang and Chen (2011), among others.

Subsequently, Figures 8 to 10 plot the evolution of all the data series over time, from statistical package for time-series econometric analysis, EViews. The Figures, depict the peaks and troughs of uncertainty measures, oil prices, global real economic activity and world oil production. The selected time period of data includes the global financial crisis in 2007-2009 and the debt crisis of Greek in 2011. Therefore, during the period 2008, there are strong fluctuations such as, the fall in global economic activity and Brent crude prices of oil, as well as to the uncertainty measures.

In the sequel, Tables 2 to 4, present the descriptive statistics of the examined data series: the three oil variables (DPROD, REA, and DOP) and the aforementioned uncertainty indices (DCCI, CFNAI, CV, DCPI, EMU, EPU, DMISERY, PMI, RV and VIX). It is also necessary the explanatory series to be stationary, in order to continue the process of assessment of reduced-form Structural VAR models.

However, the Augmented Dickey Fuller test[65] (ADF-Statistic) is employed, for testing unit root at a=1%, a=5% and a=10% significance levels. From the investigation for stationarity of the variables in the Structural VAR model, the results show that the residuals are stationary with t – statistic[66] value less than the ADF value. In particular, the null hypothesis of non-stationarity is rejected, based on ADF test and all variables are stationary. More analytical, after the ADF test for presence of unit root for non-stationarity, concludes that:

The following variables: DPROD, DOP, DCPI, CV, EMU, EPU, DMISERY and VIX are stationary for each significance level, a = 1%, a = 5% and a = 10%. Respectively the index of DCCI after test for unit root in 1st difference is stationary for any significance level a = 1%, a = 5% and a = 10%. Also, the data series of REA, CFNAI and PMI are also stationary for a = 5% and a = 10% significance levels. The non-stationarity of the RV index is not major concern since the findings presented in the next chapter are reasonably estimated and the residuals have stationary movement.

As regards the length of lags of the Structural VAR models, is determined by Akaike information criterion (AIC). With accuracy, the AIC criterion for each of the ten structural VAR models are the following: model 1 with three lags, model 2 with three lags, model 3 with three lags, model 4 with two lags, model 5 with two lags, model 6 with two lags, model 7 with two lags, model 8 with two lags, model 9 with two lags and model 10 with five lags.

[65] Note: ADF denotes Augmented Dickey Fuller statistical tests with 1%, 5% and 10% critical values of -3.456, -2.872 and -2.572, respectively.

[66] According to the definition from: https://en.wikipedia.org/wiki/T-statistic, “In statistics, the t-statistic is a ratio of the departure of an estimated parameter from its notional value and its standard error and is used in hypothesis testing, for example in the Student’s t-test, in the augmented Dickey–Fuller test, and in bootstrapping”.

Figure 8: *Monthly Data Series Employed in this Study from January 1994 to March 2015 of: World Oil Production (DPROD), Global Real Economic Activity (REA) and Brent Crude Oil Prices (DOP) for the United States*

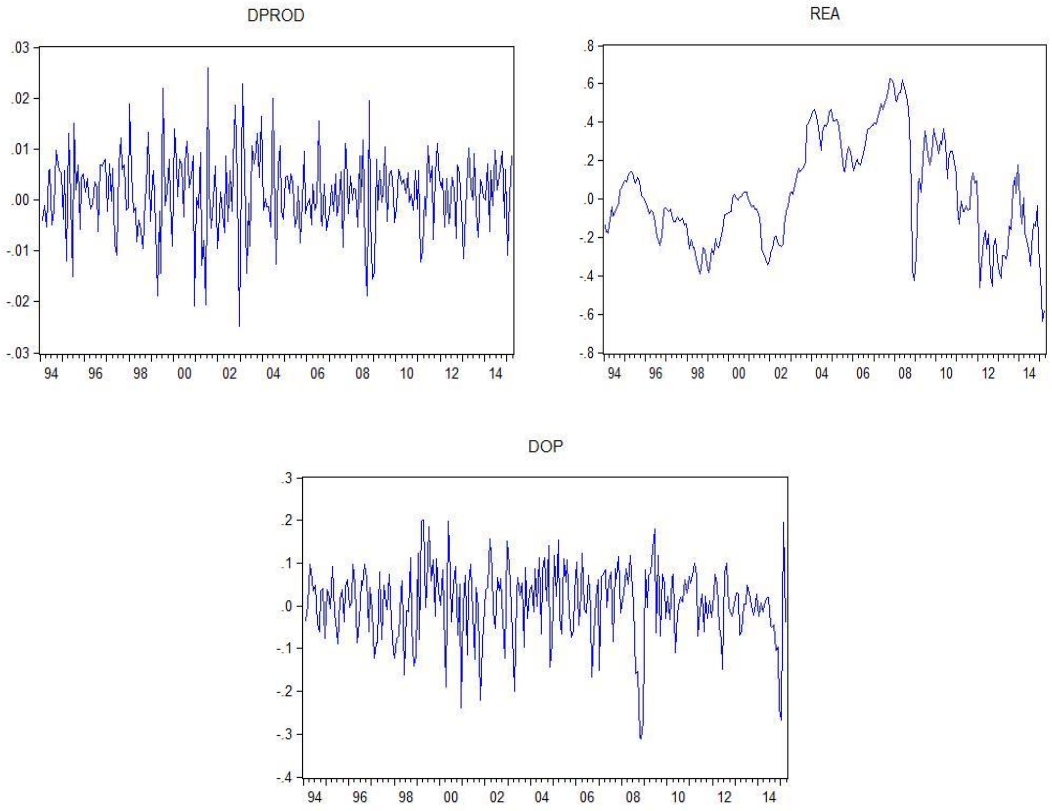
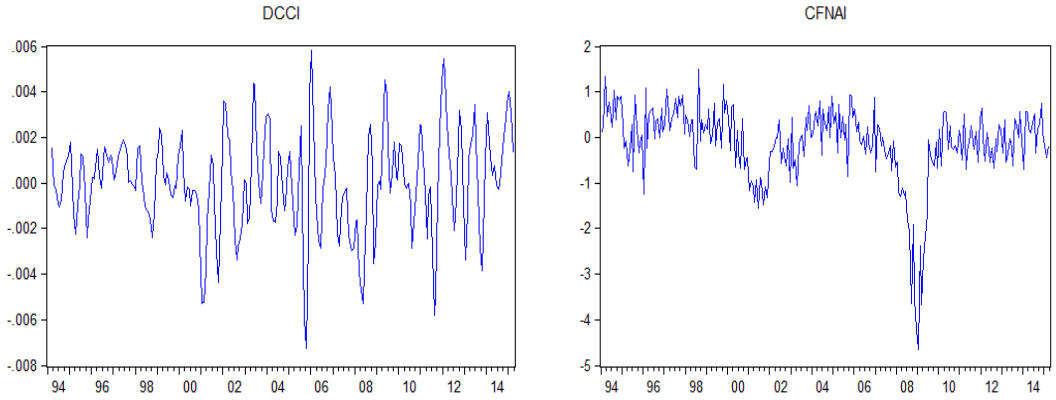


Figure 9: *Monthly Data Series Employed in this Study from January 1994 to March 2015 of Uncertainty Measures: Consumer Confidence Indicator (DCCI), Chicago Fed National Activity Index (CFNAI), Conditional Volatility (CV), Consumer Price Index (DCPI) and Equity Market Uncertainty Index (EMU) for the United States*



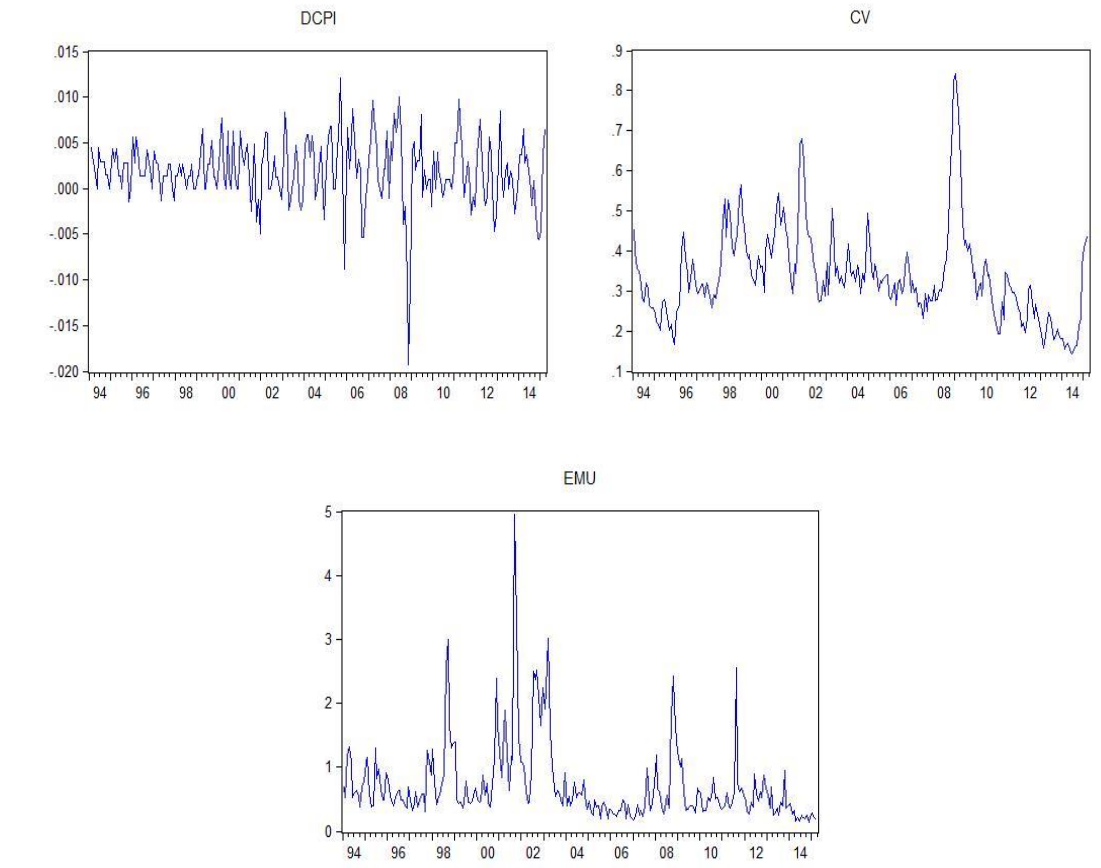
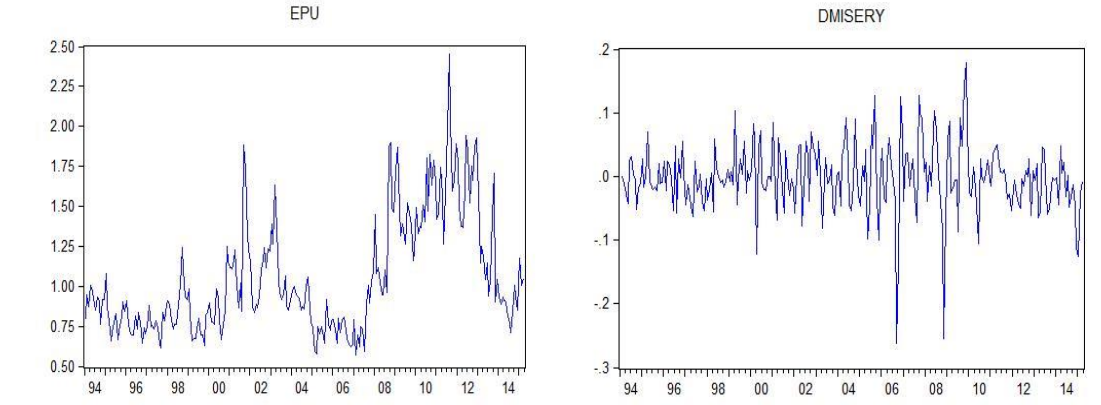


Figure 10: *Monthly Data Series Employed in this Study from January 1994 to March 2015 of Uncertainty Measures: Economic Policy Uncertainty index (EPU), Misery Index (DMISERY), Purchasing Managers Index (PMI), Realized Volatility (RV) and CBOE Volatility Index (VIX) for the United States*



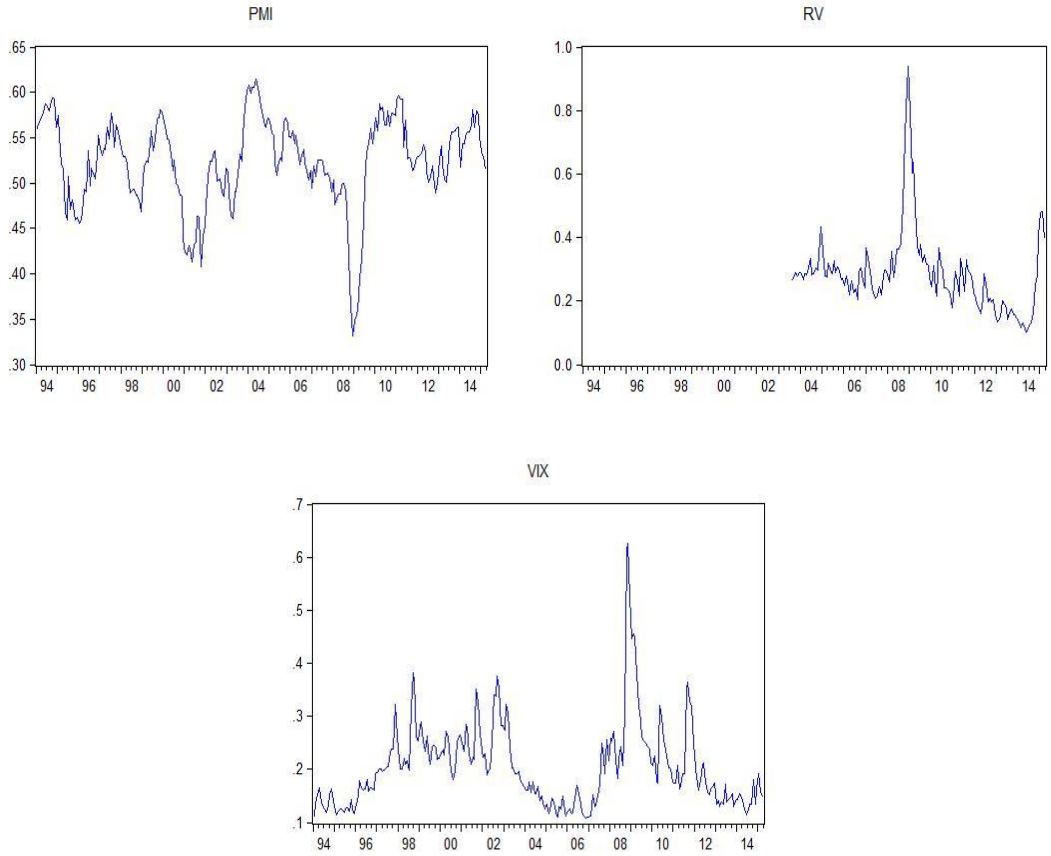


Table 2: *Descriptive Statistics (Panel A), for the Period under Examination, January 1994 until March 2015 of World Oil Production (DPROD), Global Real Economic Activity (REA) and Brent Crude Oil Prices (DOP) for the United States*

Descriptive Statistics

Panel A	**DPROD**	**REA**	**DOP**
Mean	0.001292	0.030866	0.005369
Median	0.001614	0.000972	0.014651
Maximum	0.025886	0.624842	0.200671
Minimum	-0.024870	-0.638636	-0.310955
Std. Dev.	0.007765	0.270323	0.088538
Skewness	-0.172.415	0.266.741	-0.760.685
Kurtosis	3.913.590	2.310.552	4.242.753
Jarque-Bera	1.009.179	8.074.372	4.084.107
Probability	0.006436	0.017647	0.000000
ADF test	-13.764	-2.928	-13.034

Table 3: *Descriptive Statistics (Panel B), for the Period under Examination, January 1994 until March 2015 of Uncertainty Measures: DCCI, CFNAI, CV, DCPI and EMU for the United States*

Descriptive Statistics					
Panel B	**DCCI**	**CFNAI**	**DCPI**	**CV**	**EMU**
Mean	2.47E-05	-0.133059	0.001891	0.338127	0.724341
Median	-2.55E-05	-0.010000	0.001870	0.320899	0.524668
Maximum	0.005800	1.500000	0.012135	0.843839	4960317
Minimum	-0.007227	-4.650000	-0.019319	0.143936	0.130928
Std. Dev.	0.002144	0.854816	0.003584	0.114680	0.620750
Skewness	-0.280.501	-2.050.479	-1.012.015	1.397.626	2.791.761
Kurtosis	3.519.602	9.892.516	7.980.229	6.419.538	1.370.010
Jarque-Bera	6.163.817	6.834.492	3.058.517	2.072.584	1.547.720
Probability	0.045872	0.000000	0.000000	0.000000	0.000000
ADF test	-7.436	-2.984	-10.347	-4.122	-6.727

Table 4: *Descriptive Statistics (Panel C), for the Period under Examination, January 1994 until March 2015 of Uncertainty Measures: EPU, DMISERY, PMI, RV and VIX for the United States*

Descriptive Statistics					
Panel C	**EPU**	**DMISERY**	**PMI**	**RV**	**VIX**
Mean	1.049702	-0.002041	0.523114	0.284833	0.204035
Median	0.923798	-0.004591	0.528000	0.274834	0.191200
Maximum	2.451267	0.178581	0.614000	0.937555	0.626400
Minimum	0.572026	-0.261426	0.331000	0.099783	0.108200
Std. Dev.	0.361274	0.052787	0.049957	0.128163	0.080678
Skewness	1.119.888	-0.547.147	-1.014.765	2.327.585	1.872.265
Kurtosis	3.586.635	7.128.899	4.591.157	1.078.652	8.618.360
Jarque-Bera	5.695.786	1.930.960	7.066.446	4.800.866	4.843.670
Probability	0.000000	0.000000	0.000000	0.000000	0.000000
ADF test	-4.360	-6.377	-2.981	-2.541	-3.708

3.2.1 Data Sources

The data for two measures of uncertainty, the Economic Policy Uncertainty Index and Equity Market Uncertainty Index for United States have been extracted from the website[67] of Baker *et al.*, (2013). In addition, monthly changes in World Oil Production in thousand barrels comes from International Energy Statistics[68].

[67]In more details, the United States monthly policy uncertainty index appears at http://www.policyuncertainty.com/us_monthly.html and the United States monthly equity market index appears at http://www.policyuncertainty.com/equity_uncert.html

[68]http://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=50&pid=53&aid=1&cid=ww,&syid=1994&eyid=2015&freq=M&unit=TBPD

Also, the global real economic activity index comes from Lutz Kilian's personal server[69]. Brent Crude Oil Prices have been extracted from FRED database at Federal Reserve Bank of St. Louis[70] to represent the oil market.

As well, the monthly data for four measures of uncertainty in the United States: the Purchasing Managers Index, the Chicago Board Options Exchange Volatility Index, the Consumer Confidence Index and the Chicago Fed National Activity Index come from FRED database at Federal Reserve Bank of St. Louis.

Another uncertainty index for the United States, monthly Consumer Price Index has been extracted from OECD.Stat[71]. Moreover, the monthly United States Misery index by economist Arthur Okun has been extracted from corresponding website[72].

The monthly Conditional Volatility of crude oil is estimated from daily Conditional Volatility which is extracted from Degiannakis *et al.*, (2014), where is calculated with APARCH (1, 1) model of Ding *et al.*, (1993), with Student-t distribution in error terms. In details, the monthly Conditional Volatility is computed using two steps: in the first step is estimated the sum of the daily values of volatility per month in the sample. Thereafter, in the second step is estimated as the square root of the product of the sum of conditional volatilities with the number twelve that reflects the total number of months of the year.

The monthly Realized Volatility of crude oil is also estimated from daily database. Concretely the monthly Realized Volatility is calculated with the average of the daily Conditional Volatility of each month.

[69] REA index comes from http://www-personal.umich.edu/~lkilian/paperlinks.html and especially from the link Updated version of the index of global real economic activity in industrial commodity markets, proposed in "Not all oil price shocks are alike ...", monthly percent deviations from trend, 1968.1-2015.9 among others in Lutz Kilian's server.

[70] The FRED website is: https://research.stlouisfed.org/fred2/

[71] http://stats.oecd.org/index.aspx?querytype=view&queryname=221#

[72] http://www.miseryindex.us/indexbymonth.aspx, in details, the unemployment data is extracted from the United States Department of Labor and the inflation rate comes from the Bureau of Labor Statistics.

Chapter 4

Empirical Findings

4.1 Responses to Structural Shocks

The particular use of the Structural VAR model is to examine the dynamics regarding the responses of each uncertainty measure to unexpected structural oil price shocks, as referred to Kilian and Park (2009). More specifically, this Chapter presents the empirical findings of Structural VAR models for uncertainty indicators in terms of the impulse response functions (IRFs). Consequently, the Structural VAR model is used as a reference model that allows for the estimation the impulse responses to one standard deviation structural shocks from the empirical data. In particular, the three types of oil price shocks are normalized and the Structural VAR models are manufactured by the method of reduced-form structural VAR model.

Figure 11 reports the cumulative impulse responses of each uncertainty series to one standard deviation structural shocks from the supply side of crude oil, the aggregate demand of crude oil and the precautionary oil demand for a time period of 24–months (see analytically Appendix A, Tables 5 to 14).

Starting the analysis from an unexpected positive oil supply shock (Shock 1) and specifically looking at the first column of Figure 11 the following cumulative actual responses are observed.

None of the uncertainty indicators exhibits any significant response to oil supply shock with only exception the Chicago Fed National Activity Index. Consequently, the oil supply shocks are anticipated, as markets and economies worldwide are familiar with OPEC practices hence they do not react to such oil price shocks.

In particular for the Chicago Fed National Activity Index we observe that increases as a response to a positive supply side shock, yet only marginally and only for the short-run. Consequently, the oil supply shocks could trigger short-lived overall economic activity of the United States and specifically in the sectors of production, income, employment, unemployment and hours, personal consumption, housing, sales, orders and stocks.

Focusing on the second column of Figure 11, this illustrates the aggregate demand shocks (Shock 2). The findings are as follows.

After a positive aggregate oil demand shock, the uncertainty is either reduced or remains unchanged for the majority of the indices. Nevertheless, there are indices that exhibit a positive response. In particular, the response is positive for the Chicago Fed National Activity Index (lasted for ten months) and the Purchasing Managers Index (which is short-lived) as well as the Misery index, which also lasts for the short-run.

Specifically, when oil prices rise due to aggregate oil demand shock then the economies worldwide receive it as positive news and consequently we notice that increases the Chicago Fed National Activity Index and the Purchasing Managers Index. Therefore, the stimulus to economic activity of the United States is positive and the surveys give positive responses about how the Managers see the industry in

production level, new orders from customers, supplier deliveries, inventories and employment level.

Especially, great sense causes the fact that a positive aggregate oil demand shock increases the Misery index although the uncertainty decreases and the market news are promising. It is worth noting that the interesting reactions of the Misery Index to aggregate oil demand shocks deserves further investigation.

There are also indicators that do not respond to the effects of aggregate oil demand shock, such as the Consumer Confidence Indicator, the Consumer Price Index and the Economic Policy Uncertainty Index. Although the conditions in the economic activity of the United States show encouraging after a positive oil demand shock the oil prices rise, an explanation is given by the implementation of monetary policy in the United States which leads to inflationary stability therefore, the "basket" of the consumers, their expectations about the economic activity and the volume of the newspapers' articles for the uncertainty of economic policy, are not influenced significantly.

Furthermore, aggregate oil demand shocks have negative effect on the following indicators: Conditional Volatility of crude oil, Equity Market Uncertainty Index, Realized Volatility of crude oil and Implied Volatility Index of S&P 500, since the financial markets reflect positive news and thus the uncertainty falls. In details, a positive aggregate oil demand shock decreases the Conditional Volatility of crude oil for the period between two and five months and reduces the Equity Market Uncertainty Index for long-run period since the influence does not fade out for two years.

However, the effect of a positive aggregate oil demand shock is negative for the first three months in the Realized Volatility of crude oil but is also negative to the Implied Volatility Index of S&P 500 for the first nine months as is expected due to the long memory of this uncertainty measure, while the market news are positive and the economic policy uncertainty decreases. An interesting fact is that the Equity Market Uncertainty Index has significant negative response for two years and reflects the broad range of United States newspapers that mentions the fall of uncertainty.

Finally, the effects of an unanticipated positive oil precautionary demand shock (Shock 3) are presented in the third column of Figure 11.

Notably, the Consumer Confidence Indicator reacts negatively to Shock 3. Namely, when positive oil precautionary demand shocks, the uncertainty increases and therefore the negative market news reduce the consumer sentiment, their feel for the performance of the economy and their expectations on the evolution of the economy in the first two to four months.

In addition, the Shock 3 has no significant effects on Economic Policy Uncertainty Index and the Equity Market Uncertainty Index, although we expected positive responses. More specifically, according to the structural components of the Economic Policy Uncertainty Index and the Equity Market Uncertainty Index, is observed that after a positive precautionary oil demand shock, the federal tax code of the United States does not contain provisions which alter the uncertainty as well as the volume of the United States newspapers are not reported extensively in such oil price shocks.

Regarding the Misery Index and the Consumer Price Index denote that have positive and significant response to oil precautionary demand shocks for two years. In particular, the growing uncertainty in oil prices, leads to the appreciation of oil price

which further increases the unemployment and inflation and therefore reduces the consumption of products and services.

Furthermore, Figure 11 shows that the Conditional Volatility of crude oil, the Realized Volatility of crude oil and the Implied Volatility Index of S&P 500 react negatively to Shock 3. In particular, Conditional Volatility and the Realized Volatility of crude oil have a significant negative response for two years while the Implied Volatility Index of S&P 500 only for the first seven months.

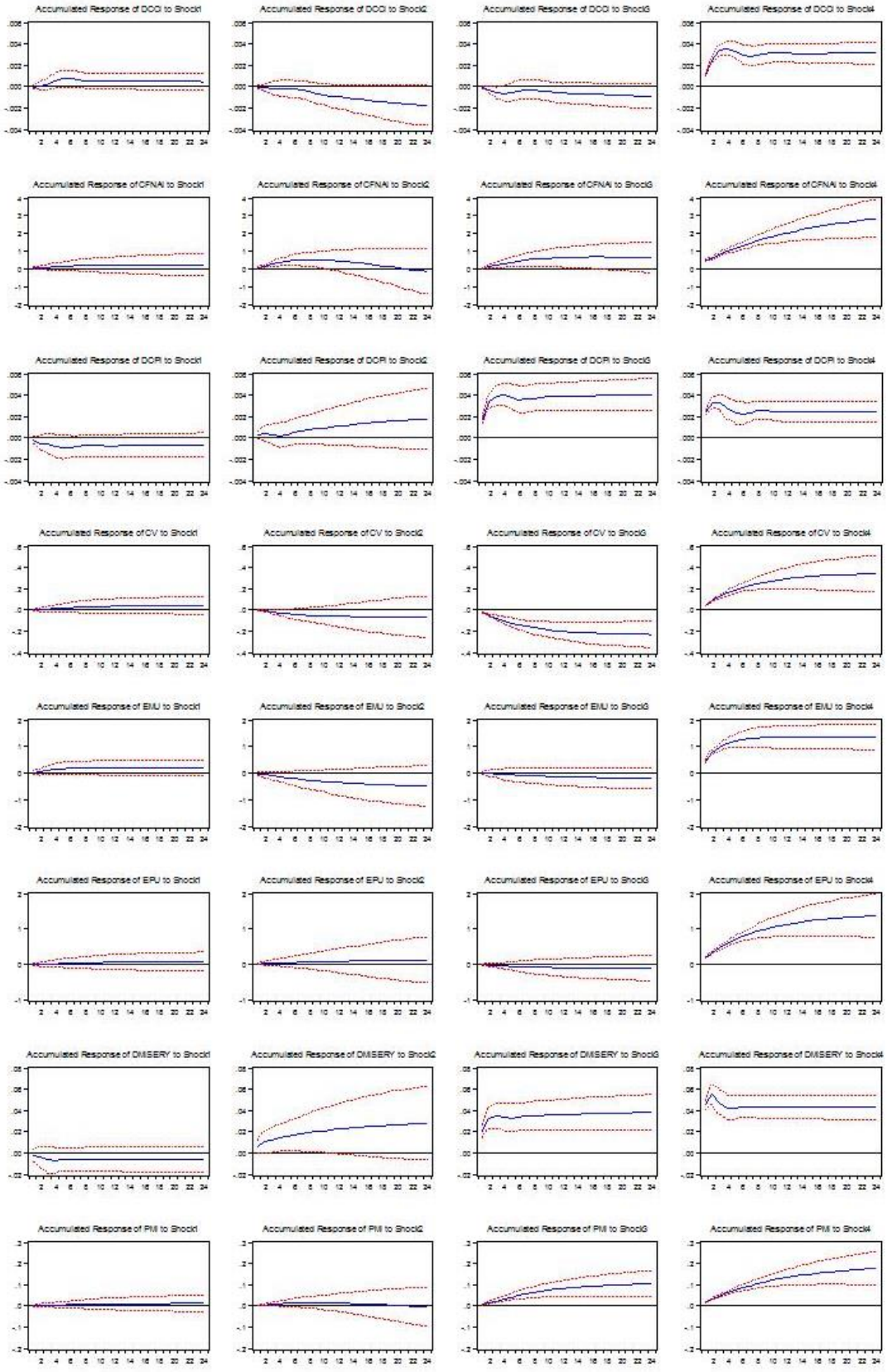
Therefore, although the news are discouragingly in the oil market after such a positive shock since the uncertainty rises, the volatility of crude oil decreases. One possible explanation is attributed to the behavior of consumers who are increasing their expenditures for obtaining crude oil despite the high price level shown in the Consumer Price Index. Therefore, the United States economy is firmly upward while more dollars are in circulation and the volatility indicators are kept low. Hence, a positive precautionary oil demand shock does not appear to increase the volatility of crude oil so this unexpected response requires further investigation.

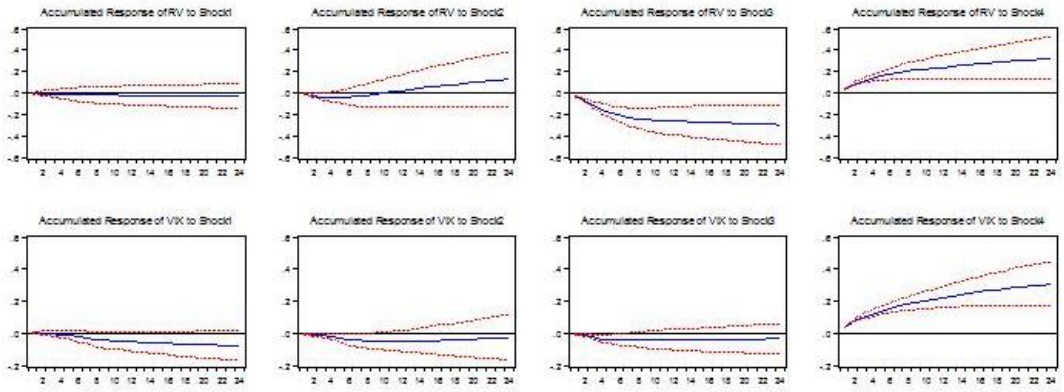
Concerning the Chicago Fed National Activity Index and the Consumer Purchasing Managers Index, is visible that their responses to precautionary demand oil shocks are similar. More precisely, both of them have a significant positive response for more than one year, especially the Chicago Fed National Activity Index reacts for fourteen months and the Consumer Purchasing Managers Index for the whole 24-month period.

Hence, an unexpected positive oil precautionary demand shock leads to acceleration of economic growth in the United States compared with the average increase for about one year and two months while the sense for international economic activity is promising the first two years although the uncertainty is rising to the international economy. Thus, the reactions of the Chicago Fed National Activity Index and the Consumer Purchasing Managers Index are contrary with their rational reactions to a positive precautionary oil demand shock, which increases the level of uncertainty and consequently rises these indicators. Therefore, these interesting unexpected reactions require further investigation.

In conclusion, the actual impulse responses of oil supply shocks do not exercise any significant impact on equivalent indicators of uncertainty. Correspondingly, the aggregate oil demand shocks responses have greater weight and provide more information. However, the precautionary oil demand shocks present the most noticeable findings that deserve further investigation.

Figure 11: *Distributions of Cumulative Impulse Responses of the Ten Uncertainty Indices per Series in Respective Shocks (Shock 1: SS, Shock 2: ADS and Shock 3: OSS) for 24 Periods*





Note: Shocks successively refers to: Shock 1 to Oil Supply Shocks (DPROD), Shock 2 to Aggregate Oil Demand Shocks (REA), and Shock 3 to Precautionary Oil Demand Shocks/Oil Specific Demand Shocks (DOP). In additional, the series of uncertainty measures (UNCERT), vertically, are the following: Consumer Confidence Indicator (DCCI), Chicago Fed National Activity Index (CFNAI), Consumer Price Index (DCPI), Conditional Volatility of Crude Oil (CV), Equity Market Uncertainty Index (EMU), Economic Policy Uncertainty Index (EPU), Misery Index (DMISERY), Purchasing Managers Index (PMI), Realized Volatility of Crude Oil (RV) and Implied Volatility Index of S&P 500 (VIX).

Chapter 5

Conclusion

This dissertation, examines the dynamic relationship between the uncertainty which distinguishes the economic policy to the oil price using monthly data over the period 1994:01-03:2015 for the United States.

More specifically, the decomposition of oil price shocks (oil supply shocks, aggregate oil demand shocks and precautionary oil demand shock) is conducted according to Kilian and Park (2009). The following measures of uncertainty: Consumer Confidence Indicator, Chicago Fed National Activity Index, Consumer Price Index, Conditional Volatility of Crude Oil, Equity Market Uncertainty Index, Economic Policy Uncertainty Index, Misery Index, Purchasing Managers Index, Realized Volatility of Crude Oil and Implied Volatility Index of S&P 500, are imported to the Structural VAR models.

The results are in line with the financial literature[73], as well as with the imposed restrictions of Kilian and Park (2009) who require the disturbances in the world oil production to have direct impact in the global real economic activity and usually do not affect the uncertainty. Also the findings are relevant as international economies are familiar with the practices implemented by OPEC on crude oil production. It should be stressed that the Chicago Fed National Activity Index has positive response to oil supply shocks and in details, could trigger positive effects in the sectors of production, income, employment, unemployment and hours, personal consumption, housing, sales, orders and stocks.

In general, after a positive aggregate oil demand shock, the uncertainty is either reduced or remains unchanged for the majority of the indices. The Chicago Fed National Activity Index and the Purchasing Managers Index as well as the Misery index, exhibit a positive response consequently, the stimulus to economic activity of the United States is positive and surveys give positive responses about how the Managers see the industry sector. However, an interesting result is the fact that a positive aggregate oil demand shock increases the Misery index although the uncertainty decreases and the market news are promising. Since there is no literature that employs the Misery Index as a measure of uncertainty, the interesting reactions of this index to oil supply shocks deserves further investigation.

Additionally, the Consumer Confidence Indicator, the Consumer Price Index and the Economic Policy Uncertainty Index, do not respond to the impact of aggregate oil demand shock, which is unexpected according to the available literature[74] and the rationally expectations. One possible cause of these responses is given by the implementation of monetary policy in the United States which leads to

[73] Jones and Kaul (1996), Park and Ratti (2008), Degiannakis *et al.*, (2014), Bloom (2009), Filis *et al.*, (2011), Antonakakis *et al.*, (2014), Kilian and Park (2009), Hooker (2002), Kilian (2009), Hamilton (2009a, b), Aloui *et al.*, (2015), Alquist and Kilian (2010) and Stock and Watson (2012), among others.

[74] Existing literature which include evidence about the inflation: Natal (2012), Montoro (2012), Malliaris and Malliaris (2013), Filis and Chatziantoniou (2013) and Balke *et al.*, (2010) and about uncertainty measures which constructed by Baker *et al.*, (2013): Rossini (2013), Colombo (2013), Aastveit *et al.*, (2013), Balcilar *et al.*, (2015), Bekiros *et al.*, (2015), Kang and Ronald (2015), Antonakakis *et al.*, (2014), Karnizova and Li (2014) and Sum (2013), among other investigations.

inflationary stability thus, the "basket" of consumers and the future expectations for the national economy are not affected significantly.

It worth noting that, an aggregate oil demand shock has strong negative impulse response on the following indicators: Conditional Volatility of crude oil, Equity Market Uncertainty Index, Realized Volatility of crude oil and Implied Volatility Index of S&P 500. We observe that these reactions verifies the expectations according to the literature[75], given that financial markets reflect the positive news and therefore the uncertainty falls. Furthermore, the fact that the impulse response of the Equity Market Uncertainty Index to aggregate oil demand shock is negative, confirms the literature[76] and reflects the wide range of United States newspapers that mentions the fall of uncertainty.

In the sequel, the precautionary oil demand shocks have the most impressive findings The Consumer Confidence Indicator reacts negatively to positive precautionary oil demand shocks in the short-run period, while expresses the discomfort of the consumers that confirms the rationally expectations. Additionally, the Economic Policy Uncertainty index and the Equity Market Uncertainty index do not provide any information after a precautionary oil price shock although according to other investigations[77], are expected to react positively.

Thus, an explanation is given according to the structural components of the Economic Policy Uncertainty Index and the Equity Market Uncertainty Index. In details, the volume of the United States newspapers are not reported extensively in such oil price shocks as well as the federal tax code of the United States does not contain provisions which shift the uncertainty. Furthermore, the Consumer Price Index and the Misery Index verify the expected impacts[78] of such an oil price shock, because the growing uncertainty in oil prices, leads to the appreciation of oil price which further increases the unemployment and inflation and therefore reduces the consumption of products and services.

Another interesting result is that the Conditional Volatility of crude oil, the Realized Volatility of crude oil and the Implied Volatility Index of S&P 500 react negatively to precautionary oil demand shocks and very opposite to the available literature[79]. A possible cause is attributed to the behavior of consumers who are increasing their expenditures for obtaining crude oil despite the high price level so, the United States economy is firmly upward while more dollars are in circulation and the volatility indicators are kept low. Undoubtedly, this unexpected response requires further investigation. Finally, the actual impulse responses of precautionary oil demand shocks exercise positive influence to the Chicago Fed National Activity Index

[75] See indicative literature about the volatility indices: Aloui *et al.*, (2015), Jones and Kaul (1996), Park and Ratti (2008), Degiannakis *et al.*, (2014), Bloom (2009), Filis *et al.*, (2011), Antonakakis *et al.*, (2014) and Zhang and Chen (2011).

[76] See Baker *et al.*, (2013) and Karnizova and Li (2014).

[77] Relevant researches that provide evidence about economic policy indices: Baker *et al.*, (2013), Bekiros *et al.*, (2015) Antonakakis *et al.*, (2014) and Karnizova and Li (2014).

[78] Relative literature which provide evidence about the inflation: Natal (2012), Montoro (2012), Malliaris and Malliaris (2013), Filis and Chatziantoniou (2013) and Balke *et al.*, (2010).

[79] See Aloui *et al.*, (2015), Jones and Kaul (1996), Park and Ratti (2008), Degiannakis *et al.*, (2014), Bloom (2009), Filis *et al.*, (2011), Antonakakis *et al.*, (2014) and Zhang and Chen (2011), existing surveys about the volatility of crude oil.

and the Consumer Purchasing Managers Index despite the fact that the rational responses are supposed to be negative, so these impacts deserve further investigation.

In conclusion, the empirical findings are showing a great deal of variety and present the interesting visuals of the dynamic relationship between oil prices with the uncertainty of economic policy.

References

Aastveit, K.A., Natvik, G.J., and, Sola, S. (2013). Economic Uncertainty and the Effectiveness of Monetary Policy. *Norges Bank's Working Paper*, 1-34.

Abel, A.B., and, Bernanke, B.S. (2001). *Macroeconomics.* Addison Wesley Longman Inc.

Aloui, C., and, Jammazi, R. (2009). The Effects of Crude Oil Shocks on Stock Market Shifts Behaviour: A Regime Switching Approach. *Energy Economics* 31, 789-799.

Aloui, R., Gupta, R., and, Miller, S.M. (2015). Uncertainty and Crude Oil Returns. *University of Connecticut, Department of Economics Working Paper Series*, 1-21.

Alquist, R., and, Kilian, L. (2010). What Do We Learn from the Price of Crude Oil Futures? *Journal of Applied Econometrics* 25, 539-573.

Alquist, R., Kilian, L., and, Vigfusson, R.J. (2011). Forecasting the Price of Oil. *Handbook of Economic Forecasting*, 2, *Amsterdam: North-Holland.*

Antonakakis, N., Chatziantoniou, I., and, Filis, G. (2014). Dynamic Spillovers of Oil Price Shocks and Policy Uncertainty. *WU Department of Economics Working Paper Series*, 1-29.

Apergis, N., and, Miller, S.M. (2009). Do Structural Oil - Market Shocks Affect Stock Prices? *Energy Economics* 31(4), 569-575.

Arouri, M.E.H., and, Nguyen, D.K. (2010). Oil Prices, Stock Markets and Portfolio Investment: Evidence from Sector Analysis in Europe Over the Last Decade. *Energy Policy* 38, 4528-4539.

Arouri, M.E.H., and, Rault, C. (2012). Oil Prices and Stock Markets in GCC Countries: Empirical Evidence from Panel Analysis. *International Journal of Finance and Economics* 17(3), 242-253.

Arouri, M.E.H., Lahiani, A., Lévy, A., and, Nguyen, D.K. (2012). Forecasting the Conditional Volatility of Oil Spot and Futures Prices with Structural Breaks and Long Memory Models. *Energy Economics* 34, 283-293.

Bachmann, R., Elstner, S., and, Sims, E.R. (2010). Uncertainty and Economic Activity: Evidence from Business Survey Data. *NBER Working Papers 16143, National Bureau of Economic Research, Inc.*

Backus, K.D., and, Crucini, M.J. (2000). Oil Prices and the Terms of Trade. *Journal of International Economics* 50, 185-213.

Baker, S., Bloom, N., and. Davis, S. (2013). Measuring Economic Policy Uncertainty. *Chicago Booth Research Paper No.13-02*.

Balke, N.S., Brown, S.P., and, Yücel, M.K. (2010). Oil Price Shocks and US Economic Activity: An International Perspective. *Working Papers 1003, Federal Reserve Bank of Dallas, Dallas Fed WP*.

Bashar, O.H.M.N, Walud, I.K.M.M., and, Ahmed, H.J.A. (2013). Oil Price Uncertainty, Monetary Policy and the Macroeconomy: The Canadian Perspective. *Economic Modelling* 35, 249-259.

Basher, S.A., Haug, A.A. and, Sadorsky, P. (2012). Oil Prices, Exchange Rates and Emerging Stock Markets. *Energy Economics* 34(1), 227-240.

Baum, C.F., Caglayan, M., and, Talavera, O. (2010). On the Sensitivity of Firms's Investment to Cash Flow and Uncertainty. *Oxford Economic Papers* 62(2), 286-306.

Baumeister, C. and, Peersman, G. (2012). The Role of Time-Varying Price Elasticities in Accounting for Volatility Changes in the Crude Oil Market. *Journal of Applied Econometrics*.

Baumeister, C., and, Kilian, L. (2012). Real-Time Analysis of Oil Price Risks Using Forecast Scenarios. *Bank of Canada Working Paper*, 1-32.

Bekiros, S., Gupta, R., and, Paccagnini, A. (2015). Oil Price Forecastability and Economic Uncertainty. *DEMS Working Paper Series*, 1-9.

Benati, L. (2013). Economic Policy Uncertainty and the Great Recession. *Department of Economics Working Paper, University of Bern*, 1-43.

Bernanke, B.S. (2006). *The Economic Outlook. Remarks Before the National Italian American Foundation.* New York: 2006.

Bernanke, B.S. (1983). Irreversibility, Uncertainty, and Cyclical Investment. *The Quarterly Journal of Economics* 98(1), 85-106.

Bernanke, B.S., Gertler, M., and, Watson, M. (1997). Systematic Monetary Policy and the Effects of Oil Price Shocks. *Brookings Papers on Economic Activity* 1, 91-142.

Bjørnland, C.H. (2009). Oil Price Shocks and Stock Market Booms in An Oil Exporting Country. *Scottish Journal of Political Economy* 2(5), 232-254.

Blanchard, J.O., and, Gali, J. (2007). The Macroeconomic Effects of Oil Price Shocks. Why Are the 2000s So Different than the 1970s? *National Bureau of Economic Research, 13368 Working Paper*.

Blanchard, O.J. and, Quah, D. (1989). The Dynamic Effects of Aggregate Demand and Supply Disturbances. *American Economic Review* 79, 654-673.

Bloom, N. (2009). The Impact of Uncertainty Shocks. *Econometrica* 77, 623-685.

Chkili, W., Hammoudeh, S., and, Nguyen, D.K. (2014). Volatility Forecasting and Risk Management for Commodity Markets in the Presence of Asymmetry and Long Memory. *Energy Economics* 41, 1-18.

Cifarelli, G., and, Paladino, G. (2010). Oil Price Dynamics and Speculation: A Multivariate Financial Approach. *Energy Economics* 32, 363−372.

Colombo, V. (2013). Economic Policy Uncertainty in the US: Does IT Matter for the Euro Area? *Economics Letters* 121, 39-42.

Degiannakis, S., Filis, G., and, Kizys, R. (2014). The Effects of Oil Price Shocks on Stock Market Volatility: Evidence from European Data. *The Energy Journal* 35(1), 35-56.

Ding, Z., Granger, C.W.J., and, Engle, R.F. (1993). A Long Memory Property of Stock Market Returns and a New Model. *Journal of Empirical Finance* 1(1), 83-106.

Du, L. Yanan, H., and, Wei, C. (2010). The Relationship between Oil Price Shocks and Chinas Macro-Economy: An Empirical Analysis. *Energy Policy* 38(8), 4142-4151.

Efimoa, O., and, Serletis, A. (2014). Energy Markets Volatility Modelling Using GARCH. *Energy Economics* 43, 264–273.

El Anshasy, A.A., and, Bradley, M.D. (2012). Oil Prices and the Fiscal Policy Response in Oil-Exporting Countries. *Journal of Policy Modeling* 34(5), 605–620.

Elder, J., and, Serletis, A. (2010). Oil Price Uncertainty. *Journal of Money, Credit and Banking* 42(6), 1137–1159.

Ewin, T.B., and, Thompson, M.A. (2007). Dynamic Cyclical Comovements of Oil Prices with Industrial Production, Consumer Prices, Unemployment and Stock Prices. *Energy Policy* 35, 5535−5540.

Fan, Y., Jiao, J.L., Liang, Q.M., Han, Z.Y., and, Wei, Y.M. (2007). The Impact of Rising International Crude Oil Price on China's Economy: An Empirical Analysis with CGE Model. *International Journal of Global Energy Issues* 27(4), 404-424 .

Filis,G. (2010). Macro Economy, Stock Narket and Oil Prices: Do Meaningful Relationships Exist among Their Cyclical Fluctuations? *Energy Economic*, 32(4), 877-886.

Filis, G., and, Chatziantoniou, I. (2013). Financial and Monetary Policy Responses to Oil Price Shocks: Evidence from Oil–Importing and Oil–Exporting Countries . *Review of Quantitative Finance and Accounting*, 1-21.

Filis, G., Degiannakis, S., and, Floros, C. (2011). Dynamic Correlation between Stock Market and Oil Prices: The Case of Oil-Importing and Oil-Exporting Countries. *International Review of Financial Analysis* 20(3), 152–164.

Hamilton, J.D. (1983). Oil and the Macroeconomy Since World War II. *Journal of Political Economy* 228-248.

Hamilton, J.D. (1988a). A Neoclassical Model of Unemployment and the Business Cycle. *Journal of Political Economy* 96, 593-617.

Hamilon, J.D. (1988b). Are the Macroeconomic Effects of Oil-Price Changes Symmetric? A Comment. *Carnegie-Rochester Conference Series on Public Policy* 28, 369-378.

Hamiltn, J.D. (1996). This is What Happened to the Oil Price Macroeconomy Relationship. *Journal of Monetary Economics* 38, 215-220.

Hamilon, J.D. (2008). *Oil and the Macroeconomy.* in New Palgrave Dictionary of Economics: Eds. S.Durlauf and L. Blume, Palgrave McMillan Ltd.

Hamilton, J.D. (2009a). Understanding Crude Oil Prices. *Energy Journal* 30(2), 179–206.

Hamilton, J.D. (2009b). Causes and Consequences of the Oil Shock of 2007–08. *Brookings Papers on Economic Activity*, 215-261.

Hamilton, J.D. (2010). Nonlinearities and the Macroeconomic Effects of Oil Prices. *NBER Working Papers 16186, National Bureau of Economic Research, Inc.* .

Hamilton, J.D. (2014). The Changing Face of World Oil Markets. *NBER Working Paper No. w20355*.

Hooker, M.A. (1996). What Happened to the Oil Price–Macroeconomy Relationship? *Journal of Monetary Economics* 38, 195–213.

Hooker, M.A. (2002). Are Oil Shocks Inflationary? Asymmetric and Nonlinear Specifications versus Changes in Regime. *Journal of Money, Credit and Banking* 34, 540-561.

Hubbard, R.G. (1998). Capital-Market Imperfections and Investment. *NBER Working Paper No. 5996*.

Jiménez-Rodríguez, R., and, Sanchez, M. (2005). Oil Price Shocks and Real GDP Growth: Empirical Evidence for Some OECD Countries. *Applied Economics* 37(2), 201-228 .

Jones, C.M., and, Kaul, G. (1996). Oil and the Stock Markets. *Journal of Finance* 51, 463-491.

Jones, P.M. and, Olson, E. (2013). The Time-Varying Correlation between Uncertainty, Output, and Inflation: Evidence from A DCC-GARCH Model. *Economics Letters* 118 (1), 33-37.

Kang, W., and, Ratti, R.A. (2013a). Structural Oil Price Shocks and Policy Uncertainty. *Economic Modelling* 35, 314-319.

Kang, W., and, Ratti, R.A. (2013b). Oil Shocks, Policy Uncertainty and Stock Market Return. *International Financial Markets. Institutions and Money* 26, 305-318.

Kang, W., and, Ratti, R.A. (2015). Policy Uncertainty in China, Oil Shocks and Stock Returns. *Economics of Transition* 23(4), 657–676.

Kilian, L. (2008). A Comparison of the Effects of Exogenous Oil Supply Shocks on Output and Inflation in the G7 Countries. *Journal of the European Economic Association* 6(1), 78-121.

Kilian, L. (2009). Not All Oil Price Shocks Are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market. *American Economic Review* 99, 1053-1069.

Kilian, L. (2011). Structural Vector Autoregressions. *CEPR Discussion Paper No. DP8515*, 1-53.

Kilian, L., and, Park, C. (2009). The impact of oil price shocks on the U.S. stock market. *International Economic Review* 50, 1267-1287.

Lee, K., and, Ni, S. (2002). On the Dynamic Effects of Oil Price Shocks: A Study Using Industry Level Data. *Journal of Monetary Economics* 49, 823-852.

Lee, K., Ni, S., and, Ratti, R.A. . (1995). Oil Shocks and the Macroeconomy: The Role of Price Variability. *Energy Journal* 16, 39-56.

Lee, Y.H., and, Chiou, J.S. . (2011). Oil Sensitivity and Its Asymmetric Impact on the Stock Market. *Energy* 36, 168−174.

Lescaroux, F., and, Mignon, V. (2008). On the Influence of Oil Prices on Economic Activity and Other Macroeconomic and Financial Variables. *OPEC Energy Review*, 32(4), 343−380.

Lippi, F. and, Nobili, A. (2012). Oil and the Macroeconomy: A Quantitative Structural Analysis. *Journal of the European Economic Association* 10(5), 1059–1083.

Maghyereh, A. (2004). Oil Price Shocks and Emerging Stock Markets: A Generalized VAR Approach. *International Journal of Applied Econometrics and Quantitative Studies* 1(2) , 27-40.

Malliaris, A., and, Malliaris, M. (2013). Are Oil, Gold and the Euro Inter-related? Time Series and Neural Network Analysis. *Review of Quantitative Finance and Accounting* 40(1), 1–14.

Marcus, A.A. (1981). Policy Uncertainty and Technological Innovation. *The Academy of Management Review* 6(3), 443-448.

Montoro, C. (2012). Oil Shocks and Optimal Monetary Policy . *Macroeconomic Dynamics* 16(02), 240–277.

Natal, J. (2012). Monetary Policy Response to Oil Price Shocks. *Journal of Money, Credit and Banking* 44(1), 53–101.

Nordhaus, W. (2007). Who's Afraid of A Big Bad Oil Shock? *Brookings Papers on Economic Activity* 2, 219−240.

Park, J. and, Ratti, R.A. (2008). Oil Price Shocks and Stock Markets in the U.S. and 13 European Countries. *Energy Economics* 30, 2587-2608.

Popescu, A., and, Smets, F.R. (2010). Uncertainty, Risk-taking, and the Business Cycle in Germany. *CESifo Economic Studies* 56(4), 596-626.

Ravazzolo, F., and, Vespignani, J.L. (2015). A New Monthly Indicator of Global Real Economic Activity. *CAMA Working Paper No. 13/2015*, 1-40.

Rodrik, D. (1991). Policy Uncertainty and Private Investment . *Journal of Development Economics* 36, 229-242.

Rossini, L. (2013). Economic Policy Uncertainty: Consequences for the Labor Market Dynamics. *University of Padua, Department of Statistics*, 1-102.

Sadorsky, P. (1999). Oil Price Shocks and Stock Market Activity. *Energy Economics* 21, 449-469.

Sévi, B. (2014). Forecasting the Volatility of Crude Oil Futures Using Intraday Data. *European Journal of Operational Research* 235, 643–659.

Sims, C. (1980). Macroeconomics and Reality. *Econometrica* 48(1) , 1–48.

Stock, J.H. and, Watson, M.W. (2003). Forecasting Output and Inflation: The Role of Asset Prices. *Journal of Economic Literature* 41, 788-829.

Stock, J.H., and, Watson, M.W. (2012). Disentangling the Channels of the 2007-2009 Recession. *NBER Working Paper No. 18094*, 1-55.

Sum, V. (2013). The ASEAN Stock Market Performance and Economic Policy Uncertainty in the United States. *Economic Papers* 35(4), 512-521.

Wang, Y., and, Wu, C. (2012). Forecasting Energy Market Volatility Using GARCH Models: Can Multivariate Models Beat Univariate Models? *Energy Economics* 34, 2167–2181.

Wei, Y., Wang, Y., and, Huang, D. (2010). Forecasting Crude Oil Market Volatility: Further Evidence Using GARCH-class Models. *Energy Economics* 32, 1477-1484.

Zhang, C. and, Chen, X. (2011). The Impact of Global Oil Price Shocks on China's Stock Returns: Evidence from the ARJI(-ht)-EGARCH Model. *Energy* 36, 6.627-6.633.

Appendix A

Table 5: *Structural Cumulative Impulse Responses of Consumer Confidence Indicator to One Standard Deviation Shock in Respective Shocks (Shock 1: SS, Shock 2: ADS and Shock 3: OSS) for 24 Periods*

Accumulated Response of DCCI:									
Period	Shock1	Shock2	Shock3	Shock4	Period	Shock1	Shock2	Shock3	Shock4
1	-3.42E-05	-3.35E-05	-8.04E-05	0.001051	13	0.000522	-0.001047	-0.000628	0.003106
	(6.7E-05)	(6.7E-05)	(6.7E-05)	(4.7E-05)		(0.00038)	(0.00063)	(0.00049)	(0.00044)
2	1.69E-05	-0.000128	-0.000309	0.002475	14	0.000511	-0.001129	-0.000646	0.003086
	(0.00017)	(0.00017)	(0.00017)	(0.00013)		(0.00038)	(0.00066)	(0.00050)	(0.00046)
3	0.000210	-0.000200	-0.000606	0.003409	15	0.000496	-0.001212	-0.000673	0.003083
	(0.00028)	(0.00028)	(0.00028)	(0.00023)		(0.00039)	(0.00070)	(0.00051)	(0.00047)
4	0.000508	-0.000215	-0.000707	0.003584	16	0.000484	-0.001293	-0.000707	0.003094
	(0.00036)	(0.00036)	(0.00036)	(0.00032)		(0.00039)	(0.00073)	(0.00051)	(0.00047)
5	0.000714	-0.000212	-0.000590	0.003298	17	0.000477	-0.001369	-0.000743	0.003106
	(0.00040)	(0.00040)	(0.00042)	(0.00039)		(0.00039)	(0.00077)	(0.00052)	(0.00047)
6	0.000734	-0.000251	-0.000407	0.002969	18	0.000475	-0.001438	-0.000777	0.003114
	(0.00040)	(0.00041)	(0.00045)	(0.00044)		(0.00040)	(0.00080)	(0.00053)	(0.00047)
7	0.000631	-0.000357	-0.000293	0.002828	19	0.000473	-0.001502	-0.000806	0.003117
	(0.00037)	(0.00041)	(0.00046)	(0.00047)		(0.00040)	(0.00083)	(0.00054)	(0.00048)
8	0.000521	-0.000506	-0.000300	0.002879	20	0.000471	-0.001562	-0.000831	0.003116
	(0.00035)	(0.00043)	(0.00045)	(0.00047)		(0.00041)	(0.00087)	(0.00055)	(0.00048)
9	0.000468	-0.000657	-0.000389	0.003009	21	0.000467	-0.001619	-0.000853	0.003115
	(0.00035)	(0.00047)	(0.00045)	(0.00045)		(0.00041)	(0.00090)	(0.00056)	(0.00049)
10	0.000472	-0.000784	-0.000494	0.003113	22	0.000463	-0.001674	-0.000875	0.003116
	(0.00036)	(0.00051)	(0.00045)	(0.00042)		(0.00041)	(0.00093)	(0.00057)	(0.00049)
11	0.000498	-0.000883	-0.000569	0.003151	23	0.000459	-0.001725	-0.000897	0.003117
	(0.00037)	(0.00055)	(0.00046)	(0.00042)		(0.00042)	(0.00096)	(0.00058)	(0.00050)
12	0.000519	-0.000966	-0.000608	0.003137	24	0.000455	-0.001774	-0.000917	0.003120
	(0.00038)	(0.00059)	(0.00047)	(0.00043)		(0.00042)	(0.00098)	(0.00059)	(0.00050)

Table 6: *Structural Cumulative Impulse Responses of Chicago Fed National Activity Index to One Standard Deviation Shock in Respective Shocks (Shock 1: SS, Shock 2: ADS and Shock 3: OSS) for 24 Periods*

Accumulated Response of CFNAI:									
Period	Shock1	Shock2	Shock3	Shock4	Period	Shock1	Shock2	Shock3	Shock4
1	0.052944	0.045181	0.022529	0.496430	13	0.215025	0.401941	0.656904	2.105.747
	(0.03158)	(0.03143)	(0.03135)	(0.02216)		(0.23948)	(0.33959)	(0.29275)	(0.27507)
2	0.067495	0.132707	0.138691	0.578752	14	0.218244	0.362306	0.666515	2.193.740
	(0.05045)	(0.04967)	(0.04920)	(0.03999)		(0.24913)	(0.36896)	(0.30857)	(0.30016)
3	0.085529	0.289020	0.174928	0.792098	15	0.220554	0.318115	0.672632	2.276.012
	(0.07394)	(0.07317)	(0.07196)	(0.05475)		(0.25808)	(0.39826)	(0.32365)	(0.32513)
4	0.124215	0.360431	0.281772	0.986910	16	0.222173	0.270282	0.675452	2.353.373
	(0.10033)	(0.09694)	(0.09819)	(0.06759)		(0.26642)	(0.42739)	(0.33804)	(0.34984)
5	0.143210	0.418886	0.372418	1.128.353	17	0.223195	0.219394	0.675507	2.426.139
	(0.11941)	(0.12090)	(0.12382)	(0.08955)		(0.27425)	(0.45626)	(0.35184)	(0.37423)
6	0.161213	0.462720	0.424806	1.296.986	18	0.223658	0.166110	0.673182	2.494.603
	(0.14057)	(0.14595)	(0.15060)	(0.10780)		(0.28163)	(0.48481)	(0.36508)	(0.39826)
7	0.170985	0.484472	0.485512	1.434.561	19	0.223661	0.110968	0.668780	2.559.163
	(0.15975)	(0.17124)	(0.17580)	(0.12949)		(0.28862)	(0.51300)	(0.37781)	(0.42189)
8	0.181227	0.497562	0.531664	1.565.616	20	0.223261	0.054423	0.662634	2.620.068
	(0.17623)	(0.19759)	(0.19841)	(0.15244)		(0.29528)	(0.54080)	(0.39007)	(0.44509)
9	0.192233	0.495804	0.568367	1.691.309	21	0.222514	-0.003102	0.654995	2.677.596
	(0.19150)	(0.22473)	(0.21997)	(0.17562)		(0.30165)	(0.56819)	(0.40189)	(0.46786)
10	0.199524	0.483948	0.599987	1.804.358	22	0.221475	-0.061255	0.646098	2.731.994
	(0.20512)	(0.25266)	(0.23987)	(0.20013)		(0.30776)	(0.59519)	(0.41330)	(0.49018)
11	0.205750	0.464190	0.623797	1.912.143	23	0.220183	-0.119724	0.636155	2.783.476
	(0.21763)	(0.28128)	(0.25852)	(0.22484)		(0.31365)	(0.62178)	(0.42433)	(0.51207)
12	0.210971	0.436154	0.642831	2.012.300	24	0.218682	-0.178237	0.625346	2.832.250
	(0.22907)	(0.31031)	(0.27614)	(0.24988)		(0.31933)	(0.64797)	(0.43500)	(0.53352)

Table 7: *Structural Cumulative Impulse Responses of Consumer Price Index to One Standard Deviation Shock in Respective Shocks (Shock 1: SS, Shock 2: ADS and Shock 3: OSS) for 24 Periods*

Accumulated Response of DCPI:									
Period	Shock1	Shock2	Shock3	Shock4	Period	Shock1	Shock2	Shock3	Shock4
1	-0.000239	0.000243	0.001663	0.002402	13	-0.000735	0.001179	0.003866	0.002432
	(0.00019)	(0.00018)	(0.00017)	(0.00011)		(0.00053)	(0.00095)	(0.00067)	(0.00047)
2	-0.000511	0.000418	0.003350	0.003285	14	-0.000723	0.001252	0.003890	0.002443
	(0.00035)	(0.00035)	(0.00032)	(0.00024)		(0.00053)	(0.00101)	(0.00067)	(0.00047)
3	-0.000524	0.000238	0.003926	0.003298	15	-0.000715	0.001318	0.003917	0.002448
	(0.00048)	(0.00048)	(0.00045)	(0.00037)		(0.00054)	(0.00106)	(0.00068)	(0.00047)
4	-0.000801	0.000198	0.003973	0.002740	16	-0.000711	0.001378	0.003938	0.002443
	(0.00056)	(0.00056)	(0.00054)	(0.00048)		(0.00054)	(0.00111)	(0.00069)	(0.00047)
5	-0.000911	0.000331	0.003745	0.002288	17	-0.000707	0.001436	0.003955	0.002436
	(0.00057)	(0.00058)	(0.00061)	(0.00053)		(0.00055)	(0.00116)	(0.00070)	(0.00048)
6	-0.000879	0.000515	0.003585	0.002221	18	-0.000703	0.001492	0.003968	0.002429
	(0.00052)	(0.00059)	(0.00064)	(0.00052)		(0.00055)	(0.00120)	(0.00071)	(0.00048)
7	-0.000794	0.000675	0.003599	0.002370	19	-0.000697	0.001544	0.003982	0.002426
	(0.00050)	(0.00062)	(0.00064)	(0.00047)		(0.00055)	(0.00125)	(0.00071)	(0.00048)
8	-0.000738	0.000784	0.003707	0.002514	20	-0.000692	0.001594	0.003996	0.002425
	(0.00050)	(0.00067)	(0.00063)	(0.00042)		(0.00056)	(0.00129)	(0.00072)	(0.00048)
9	-0.000731	0.000862	0.003805	0.002549	21	-0.000688	0.001640	0.004009	0.002423
	(0.00051)	(0.00073)	(0.00063)	(0.00042)		(0.00056)	(0.00133)	(0.00073)	(0.00048)
10	-0.000746	0.000934	0.003849	0.002506	22	-0.000684	0.001683	0.004022	0.002421
	(0.00052)	(0.00079)	(0.00063)	(0.00045)		(0.00056)	(0.00137)	(0.00074)	(0.00049)
11	-0.000754	0.001014	0.003854	0.002452	23	-0.000680	0.001724	0.004034	0.002419
	(0.00053)	(0.00084)	(0.00065)	(0.00047)		(0.00057)	(0.00141)	(0.00074)	(0.00049)
12	-0.000749	0.001098	0.003853	0.002428	24	-0.000676	0.001763	0.004045	0.002416
	(0.00053)	(0.00090)	(0.00066)	(0.00048)		(0.00057)	(0.00145)	(0.00075)	(0.00049)

Table 8: *Structural Cumulative Impulse Responses of Conditional Volatility of Crude oil to One Standard Deviation Shock in Respective Shocks (Shock 1: SS, Shock 2: ADS and Shock 3: OSS) for 24 Periods*

Accumulated Response of CV:									
Period	Shock1	Shock2	Shock3	Shock4	Period	Shock1	Shock2	Shock3	Shock4
1	8.13E-05	-0.002638	-0.024893	0.040455	13	0.035897	-0.062600	-0.207522	0.302214
	(0.00300)	(0.00299)	(0.00278)	(0.00180)		(0.03532)	(0.05775)	(0.04603)	(0.05304)
2	-0.001956	-0.011026	-0.053842	0.082377	14	0.037022	-0.063653	-0.211945	0.308803
	(0.00690)	(0.00687)	(0.00647)	(0.00473)		(0.03626)	(0.06236)	(0.04824)	(0.05714)
3	0.005084	-0.020923	-0.080339	0.120539	15	0.037980	-0.064468	-0.215679	0.314413
	(0.01143)	(0.01136)	(0.01088)	(0.00845)		(0.03707)	(0.06683)	(0.05027)	(0.06102)
4	0.011689	-0.029310	-0.104768	0.154558	16	0.038799	-0.065087	-0.218832	0.319197
	(0.01569)	(0.01594)	(0.01567)	(0.01237)		(0.03778)	(0.07112)	(0.05211)	(0.06466)
5	0.015895	-0.036398	-0.125278	0.183761	17	0.039500	-0.065549	-0.221497	0.323282
	(0.01939)	(0.02046)	(0.02032)	(0.01651)		(0.03839)	(0.07522)	(0.05379)	(0.06806)
6	0.019911	-0.042455	-0.142472	0.208368	18	0.040101	-0.065882	-0.223753	0.326776
	(0.02267)	(0.02492)	(0.02462)	(0.02083)		(0.03893)	(0.07912)	(0.05530)	(0.07124)
7	0.023588	-0.047427	-0.157140	0.229237	19	0.040617	-0.066111	-0.225662	0.329768
	(0.02545)	(0.02941)	(0.02850)	(0.02534)		(0.03941)	(0.08281)	(0.05665)	(0.07421)
8	0.026547	-0.051464	-0.169519	0.246941	20	0.041060	-0.066259	-0.227281	0.332336
	(0.02780)	(0.03399)	(0.03203)	(0.03003)		(0.03983)	(0.08628)	(0.05786)	(0.07696)
9	0.029043	-0.054756	-0.179912	0.261914	21	0.041443	-0.066341	-0.228654	0.334543
	(0.02980)	(0.03867)	(0.03527)	(0.03479)		(0.04020)	(0.08955)	(0.05894)	(0.07953)
10	0.031205	-0.057419	-0.188673	0.274591	22	0.041773	-0.066371	-0.229821	0.336444
	(0.03152)	(0.04344)	(0.03827)	(0.03954)		(0.04053)	(0.09262)	(0.05990)	(0.08191)
11	0.033032	-0.059552	-0.196059	0.285343	23	0.042059	-0.066360	-0.230813	0.338084
	(0.03298)	(0.04824)	(0.04105)	(0.04420)		(0.04083)	(0.09548)	(0.06075)	(0.08413)
12	0.034578	-0.061254	-0.202279	0.294466	24	0.042307	-0.066319	-0.231658	0.339503
	(0.03424)	(0.05303)	(0.04364)	(0.04871)		(0.04110)	(0.09815)	(0.06149)	(0.08619)

Table 9: *Structural Cumulative Impulse Responses of Equity Market Uncertainty Index to One Standard Deviation Shock in Respective Shocks (Shock 1: SS, Shock 2: ADS and Shock 3: OSS) for 24 Periods*

Accumulated Response of EMU:									
Period	Shock1	Shock2	Shock3	Shock4	Period	Shock1	Shock2	Shock3	Shock4
1	0.019739	-0.028856	8.04E-07	0.447672	13	0.198730	-0.375523	-0.145850	1.351.035
	(0.02827)	(0.02823)	(0.02820)	(0.01994)		(0.13750)	(0.26351)	(0.17342)	(0.21843)
2	0.027587	-0.068622	-0.008218	0.766918	14	0.199234	-0.392103	-0.152906	1.352.297
	(0.05602)	(0.05568)	(0.05617)	(0.04441)		(0.13829)	(0.27913)	(0.17698)	(0.22141)
3	0.097263	-0.112305	-0.030515	0.977013	15	0.199581	-0.407256	-0.159369	1.353.000
	(0.08304)	(0.08166)	(0.08353)	(0.06938)		(0.13896)	(0.29382)	(0.18043)	(0.22372)
4	0.141300	-0.148001	-0.054799	1.114.283	16	0.199828	-0.421093	-0.165280	1.353.353
	(0.10120)	(0.10324)	(0.10733)	(0.09548)		(0.13955)	(0.30757)	(0.18376)	(0.22553)
5	0.159636	-0.180181	-0.067410	1.202.756	17	0.200008	-0.433723	-0.170682	1.353.488
	(0.11211)	(0.12207)	(0.12511)	(0.12163)		(0.14006)	(0.32040)	(0.18697)	(0.22699)
6	0.173330	-0.211117	-0.077941	1.258.391	18	0.200143	-0.445248	-0.175615	1.353.490
	(0.12005)	(0.13970)	(0.13756)	(0.14529)		(0.14051)	(0.33235)	(0.19004)	(0.22819)
7	0.183315	-0.240235	-0.089685	1.293.641	19	0.200248	-0.455760	-0.180117	1.353.415
	(0.12549)	(0.15731)	(0.14619)	(0.16513)		(0.14093)	(0.34345)	(0.19296)	(0.22920)
8	0.189074	-0.267392	-0.100801	1.316.229	20	0.200330	-0.465347	-0.184225	1.353.296
	(0.12914)	(0.17533)	(0.15253)	(0.18093)		(0.14130)	(0.35375)	(0.19573)	(0.23006)
9	0.192723	-0.292680	-0.111063	1.330.596	21	0.200398	-0.474089	-0.187971	1.353.155
	(0.13183)	(0.19362)	(0.15760)	(0.19312)		(0.14164)	(0.36329)	(0.19835)	(0.23081)
10	0.195259	-0.316080	-0.120765	1.339.663	22	0.200454	-0.482061	-0.191388	1.353.006
	(0.13384)	(0.21186)	(0.16196)	(0.20236)		(0.14196)	(0.37213)	(0.20081)	(0.23148)
11	0.196918	-0.337622	-0.129819	1.345.357	23	0.200503	-0.489329	-0.194504	1.352.856
	(0.13536)	(0.22975)	(0.16595)	(0.20930)		(0.14224)	(0.38031)	(0.20313)	(0.23207)
12	0.197997	-0.357400	-0.138167	1.348.890	24	0.200544	-0.495955	-0.197345	1.352.711
	(0.13655)	(0.24702)	(0.16975)	(0.21451)		(0.14251)	(0.38787)	(0.20530)	(0.23261)

Table 10: *Structural Cumulative Impulse Responses of Economic Policy Uncertainty Index to One Standard Deviation Shock in Respective Shocks (Shock 1: SS, Shock 2: ADS and Shock 3: OSS) for 24 Periods*

Accumulated Response of EPU:									
Period	Shock1	Shock2	Shock3	Shock4	Period	Shock1	Shock2	Shock3	Shock4
1	-0.008197	0.010286	-0.014760	0.182183	13	0.058822	0.081993	-0.104292	1.160.974
	(0.01154)	(0.01152)	(0.01150)	(0.00812)		(0.11013)	(0.18305)	(0.13424)	(0.18075)
2	-0.023608	0.017305	-0.030144	0.329468	14	0.061558	0.085690	-0.106432	1.193.024
	(0.02380)	(0.02371)	(0.02383)	(0.01869)		(0.11356)	(0.19844)	(0.13998)	(0.19558)
3	-0.003225	0.022225	-0.045100	0.460682	15	0.063959	0.089077	-0.108257	1.221.182
	(0.03742)	(0.03718)	(0.03765)	(0.02957)		(0.11659)	(0.21352)	(0.14534)	(0.20974)
4	0.010557	0.029875	-0.059876	0.579011	16	0.066068	0.092178	-0.109812	1.245.918
	(0.04935)	(0.05060)	(0.05185)	(0.04146)		(0.11927)	(0.22820)	(0.15036)	(0.22319)
5	0.017364	0.037732	-0.068401	0.682363	17	0.067918	0.095018	-0.111134	1.267.645
	(0.05973)	(0.06404)	(0.06518)	(0.05473)		(0.12164)	(0.24239)	(0.15507)	(0.23589)
6	0.025224	0.044874	-0.075156	0.772163	18	0.069543	0.097617	-0.112254	1.286.727
	(0.06927)	(0.07760)	(0.07725)	(0.06910)		(0.12373)	(0.25605)	(0.15949)	(0.24782)
7	0.032497	0.051589	-0.081581	0.851269	19	0.070968	0.099995	-0.113201	1.303.483
	(0.07755)	(0.09153)	(0.08799)	(0.08441)		(0.12558)	(0.26913)	(0.16365)	(0.25901)
8	0.038315	0.057825	-0.086973	0.920897	20	0.072219	0.102171	-0.114000	1.318.197
	(0.08477)	(0.10598)	(0.09760)	(0.10040)		(0.12722)	(0.28161)	(0.16755)	(0.26945)
9	0.043487	0.063525	-0.091511	0.982023	21	0.073316	0.104161	-0.114670	1.331.114
	(0.09119)	(0.12092)	(0.10629)	(0.11674)		(0.12866)	(0.29347)	(0.17122)	(0.27916)
10	0.048130	0.068753	-0.095471	1.035.751	22	0.074279	0.105981	-0.115230	1.342.452
	(0.09685)	(0.13624)	(0.11419)	(0.13316)		(0.12994)	(0.30470)	(0.17467)	(0.28817)
11	0.052168	0.073556	-0.098881	1.082.989	23	0.075122	0.107645	-0.115697	1.352.404
	(0.10184)	(0.15180)	(0.12142)	(0.14941)		(0.13107)	(0.31531)	(0.17790)	(0.29652)
12	0.055705	0.077959	-0.101794	1.124.499	24	0.075862	0.109166	-0.116083	1.361.137
	(0.10624)	(0.16746)	(0.12807)	(0.16532)		(0.13208)	(0.32531)	(0.18093)	(0.30422)

Table 11: *Structural Cumulative Impulse Responses of Misery Index to One Standard Deviation Shock in Respective Shocks (Shock 1: SS, Shock 2: ADS and Shock 3: OSS) for 24 Periods*

Accumulated Response of DMISERY:									
Period	Shock1	Shock2	Shock3	Shock4	Period	Shock1	Shock2	Shock3	Shock4
1	-0.002798	0.006234	0.020517	0.045098	13	-0.005960	0.023101	0.036388	0.043251
	(0.00315)	(0.00313)	(0.00298)	(0.00201)		(0.00582)	(0.01241)	(0.00726)	(0.00557)
2	-0.004218	0.010184	0.032950	0.055380	14	-0.005960	0.023733	0.036625	0.043214
	(0.00516)	(0.00512)	(0.00494)	(0.00400)		(0.00586)	(0.01301)	(0.00739)	(0.00560)
3	-0.006454	0.012426	0.034821	0.047374	15	-0.005959	0.024309	0.036841	0.043183
	(0.00634)	(0.00607)	(0.00616)	(0.00564)		(0.00589)	(0.01358)	(0.00751)	(0.00563)
4	-0.006796	0.013851	0.033491	0.042376	16	-0.005958	0.024835	0.037039	0.043155
	(0.00603)	(0.00629)	(0.00668)	(0.00614)		(0.00592)	(0.01411)	(0.00763)	(0.00566)
5	-0.006041	0.015174	0.033001	0.042485	17	-0.005958	0.025314	0.037219	0.043130
	(0.00535)	(0.00670)	(0.00653)	(0.00554)		(0.00595)	(0.01460)	(0.00775)	(0.00568)
6	-0.005776	0.016535	0.033603	0.043531	18	-0.005957	0.025751	0.037384	0.043106
	(0.00534)	(0.00736)	(0.00638)	(0.00513)		(0.00598)	(0.01507)	(0.00786)	(0.00570)
7	-0.005905	0.017796	0.034375	0.043778	19	-0.005957	0.026150	0.037533	0.043085
	(0.00553)	(0.00812)	(0.00642)	(0.00520)		(0.00600)	(0.01550)	(0.00796)	(0.00573)
8	-0.005989	0.018907	0.034876	0.043573	20	-0.005956	0.026513	0.037670	0.043066
	(0.00562)	(0.00889)	(0.00658)	(0.00538)		(0.00602)	(0.01591)	(0.00806)	(0.00574)
9	-0.005982	0.019903	0.035207	0.043399	21	-0.005956	0.026845	0.037795	0.043048
	(0.00566)	(0.00964)	(0.00674)	(0.00546)		(0.00604)	(0.01629)	(0.00816)	(0.00576)
10	-0.005964	0.020814	0.035518	0.043341	22	-0.005955	0.027147	0.037909	0.043032
	(0.00570)	(0.01038)	(0.00687)	(0.00548)		(0.00606)	(0.01664)	(0.00825)	(0.00578)
11	-0.005959	0.021647	0.035832	0.043320	23	-0.005955	0.027423	0.038012	0.043017
	(0.00574)	(0.01109)	(0.00699)	(0.00550)		(0.00608)	(0.01697)	(0.00833)	(0.00579)
12	-0.005959	0.022408	0.036125	0.043290	24	-0.005955	0.027674	0.038107	0.043004
	(0.00578)	(0.01177)	(0.00712)	(0.00553)		(0.00609)	(0.01727)	(0.00841)	(0.00581)

Table 12: *Structural Cumulative Impulse Responses of Purchasing Managers Index to One Standard Deviation Shock in Respective Shocks (Shock 1: SS, Shock 2: ADS and Shock 3: OSS) for 24 Periods*

Accumulated Response of PMI:									
Period	Shock1	Shock2	Shock3	Shock4	Period	Shock1	Shock2	Shock3	Shock4
1	0.000509	0.002151	0.006148	0.016450	13	0.009232	0.011943	0.084491	0.138560
	(0.00111)	(0.00111)	(0.00107)	(0.00073)		(0.01501)	(0.02398)	(0.01951)	(0.02012)
2	0.000952	0.004788	0.012472	0.032359	14	0.009560	0.010691	0.087504	0.143747
	(0.00247)	(0.00245)	(0.00240)	(0.00182)		(0.01561)	(0.02622)	(0.02076)	(0.02206)
3	0.002688	0.007543	0.022034	0.046914	15	0.009854	0.009326	0.090164	0.148480
	(0.00409)	(0.00406)	(0.00398)	(0.00305)		(0.01615)	(0.02846)	(0.02196)	(0.02398)
4	0.004050	0.010172	0.031564	0.060479	16	0.010120	0.007878	0.092515	0.152806
	(0.00566)	(0.00577)	(0.00575)	(0.00437)		(0.01665)	(0.03067)	(0.02313)	(0.02586)
5	0.004796	0.012275	0.040468	0.072926	17	0.010361	0.006372	0.094595	0.156764
	(0.00713)	(0.00754)	(0.00754)	(0.00578)		(0.01709)	(0.03285)	(0.02424)	(0.02770)
6	0.005555	0.013736	0.048576	0.084246	18	0.010578	0.004829	0.096436	0.160393
	(0.00851)	(0.00936)	(0.00929)	(0.00730)		(0.01750)	(0.03499)	(0.02531)	(0.02950)
7	0.006308	0.014631	0.055780	0.094485	19	0.010775	0.003267	0.098067	0.163724
	(0.00976)	(0.01125)	(0.01096)	(0.00892)		(0.01788)	(0.03707)	(0.02633)	(0.03124)
8	0.006946	0.015036	0.062170	0.103743	20	0.010954	0.001701	0.099515	0.166785
	(0.01089)	(0.01321)	(0.01254)	(0.01063)		(0.01822)	(0.03911)	(0.02730)	(0.03292)
9	0.007504	0.015014	0.067825	0.112125	21	0.011116	0.000142	0.100801	0.169603
	(0.01189)	(0.01524)	(0.01405)	(0.01244)		(0.01853)	(0.04108)	(0.02823)	(0.03455)
10	0.008010	0.014634	0.072810	0.119720	22	0.011264	-0.001398	0.101945	0.172201
	(0.01280)	(0.01735)	(0.01549)	(0.01431)		(0.01882)	(0.04299)	(0.02910)	(0.03611)
11	0.008463	0.013959	0.077203	0.126609	23	0.011399	-0.002913	0.102963	0.174598
	(0.01362)	(0.01952)	(0.01687)	(0.01623)		(0.01909)	(0.04483)	(0.02993)	(0.03762)
12	0.008869	0.013046	0.081076	0.132867	24	0.011522	-0.004395	0.103870	0.176813
	(0.01435)	(0.02174)	(0.01821)	(0.01817)		(0.01934)	(0.04661)	(0.03071)	(0.03907)

Table 13*: Structural Cumulative Impulse Responses of Realized Volatility of Crude Oil to One Standard Deviation Shock in Respective Shocks (Shock 1: SS, Shock 2: ADS and Shock 3: OSS) for 24 Periods*

Accumulated Response of RV:									
Period	Shock1	Shock2	Shock3	Shock4	Period	Shock1	Shock2	Shock3	Shock4
1	-0.002162	-0.011663	-0.032176	0.040835	13	-0.023668	0.030176	-0.266712	0.246775
	(0.00454)	(0.00448)	(0.00398)	(0.00246)		(0.04580)	(0.07799)	(0.06973)	(0.05709)
2	-0.007828	-0.027537	-0.073242	0.074574	14	-0.024301	0.040749	-0.269725	0.254717
	(0.01027)	(0.01009)	(0.00898)	(0.00642)		(0.04692)	(0.08282)	(0.07271)	(0.06092)
3	-0.010479	-0.039828	-0.114715	0.105656	15	-0.024916	0.050810	-0.272649	0.262419
	(0.01705)	(0.01680)	(0.01532)	(0.01083)		(0.04804)	(0.08749)	(0.07536)	(0.06467)
4	-0.012882	-0.046206	-0.152596	0.131924	16	-0.025516	0.060371	-0.275562	0.269899
	(0.02324)	(0.02369)	(0.02257)	(0.01555)		(0.04916)	(0.09207)	(0.07776)	(0.06836)
5	-0.015302	-0.046975	-0.183940	0.153909	17	-0.026101	0.069464	-0.278487	0.277158
	(0.02839)	(0.03042)	(0.02985)	(0.02034)		(0.05028)	(0.09659)	(0.07999)	(0.07203)
6	-0.017175	-0.043214	-0.208267	0.172041	18	-0.026670	0.078127	-0.281419	0.284193
	(0.03268)	(0.03700)	(0.03664)	(0.02524)		(0.05140)	(0.10110)	(0.08212)	(0.07569)
7	-0.018582	-0.036002	-0.226258	0.187108	19	-0.027222	0.086398	-0.284337	0.290998
	(0.03604)	(0.04346)	(0.04281)	(0.03019)		(0.05251)	(0.10562)	(0.08419)	(0.07936)
8	-0.019751	-0.026454	-0.239177	0.199842	20	-0.027757	0.094312	-0.287218	0.297571
	(0.03857)	(0.04981)	(0.04842)	(0.03511)		(0.05361)	(0.11015)	(0.08624)	(0.08304)
9	-0.020734	-0.015544	-0.248312	0.210909	21	-0.028274	0.101897	-0.290042	0.303909
	(0.04052)	(0.05600)	(0.05356)	(0.03992)		(0.05469)	(0.11469)	(0.08827)	(0.08674)
10	-0.021571	-0.004003	-0.254823	0.220821	22	-0.028772	0.109177	-0.292793	0.310014
	(0.04211)	(0.06195)	(0.05827)	(0.04454)		(0.05574)	(0.11924)	(0.09030)	(0.09043)
11	-0.022318	0.007660	-0.259639	0.229951	23	-0.029252	0.116172	-0.295458	0.315890
	(0.04345)	(0.06760)	(0.06254)	(0.04893)		(0.05677)	(0.12380)	(0.09233)	(0.09413)
12	-0.023011	0.019116	-0.263448	0.238550	24	-0.029713	0.122898	-0.298030	0.321542
	(0.04465)	(0.07293)	(0.06635)	(0.05310)		(0.05778)	(0.12834)	(0.09435)	(0.09782)

Table 14: *Structural Cumulative Impulse Responses of Implied Volatility Index of S&P 500 to One Standard Deviation Shock in Respective Shocks (Shock 1: SS, Shock 2: ADS and Shock 3: OSS) for 24 Periods*

Accumulated Response of VIX:									
Period	Shock1	Shock2	Shock3	Shock4	Period	Shock1	Shock2	Shock3	Shock4
1	0.002546	-0.004591	-0.007666	0.034543	13	-0.055654	-0.050030	-0.041374	0.231849
	(0.00226)	(0.00225)	(0.00222)	(0.00155)		(0.03283)	(0.03585)	(0.03363)	(0.03489)
2	0.001004	-0.009477	-0.016037	0.071185	14	-0.058348	-0.049100	-0.041649	0.241068
	(0.00522)	(0.00518)	(0.00513)	(0.00393)		(0.03428)	(0.03876)	(0.03503)	(0.03796)
3	-0.003291	-0.014534	-0.025877	0.097407	15	-0.060995	-0.047879	-0.041693	0.249567
	(0.00841)	(0.00829)	(0.00821)	(0.00676)		(0.03572)	(0.04178)	(0.03639)	(0.04109)
4	-0.009561	-0.022089	-0.037969	0.118065	16	-0.063542	-0.046480	-0.041338	0.257572
	(0.01172)	(0.01147)	(0.01133)	(0.00969)		(0.03713)	(0.04488)	(0.03772)	(0.04424)
5	-0.015280	-0.031849	-0.043178	0.136240	17	-0.065915	-0.044802	-0.040758	0.265163
	(0.01503)	(0.01479)	(0.01439)	(0.01277)		(0.03850)	(0.04803)	(0.03903)	(0.04739)
6	-0.023651	-0.039748	-0.041878	0.153407	18	-0.068095	-0.042854	-0.040095	0.272219
	(0.01828)	(0.01793)	(0.01742)	(0.01564)		(0.03980)	(0.05121)	(0.04032)	(0.05053)
7	-0.031679	-0.045114	-0.041282	0.168413	19	-0.070102	-0.040640	-0.039391	0.278730
	(0.02123)	(0.02062)	(0.02047)	(0.01824)		(0.04104)	(0.05440)	(0.04160)	(0.05365)
8	-0.037921	-0.049146	-0.041936	0.180652	20	-0.071933	-0.038169	-0.038607	0.284767
	(0.02376)	(0.02307)	(0.02337)	(0.02088)		(0.04221)	(0.05760)	(0.04284)	(0.05672)
9	-0.042310	-0.050665	-0.042821	0.191463	21	-0.073610	-0.035492	-0.037687	0.290431
	(0.02601)	(0.02542)	(0.02607)	(0.02357)		(0.04332)	(0.06080)	(0.04405)	(0.05974)
10	-0.046058	-0.051007	-0.042801	0.201572	22	-0.075148	-0.032636	-0.036674	0.295774
	(0.02802)	(0.02783)	(0.02843)	(0.02631)		(0.04437)	(0.06400)	(0.04520)	(0.06270)
11	-0.049750	-0.051055	-0.041823	0.211782	23	-0.076546	-0.029638	-0.035633	0.300806
	(0.02978)	(0.03038)	(0.03043)	(0.02909)		(0.04537)	(0.06718)	(0.04630)	(0.06561)
12	-0.052948	-0.050651	-0.041269	0.222000	24	-0.077818	-0.026530	-0.034586	0.305533
	(0.03136)	(0.03305)	(0.03213)	(0.03193)		(0.04631)	(0.07036)	(0.04737)	(0.06845)

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