VOLKAN KAHRAMAN ASYMMETRIC EFFECTS OF BENCHMARK PRICES ON IRAQI OIL: BASRAH LIGHT, BASRAH HEAVY, AND KIRKUK Bilkent University 2021

ASYMMETRIC EFFECTS OF BENCHMARK PRICES ON IRAQI OIL:

BASRAH LIGHT, BASRAH HEAVY AND KIRKUK

A Master's Thesis

by

VOLKAN KAHRAMAN

Graduate Program in

Energy Economics, Policy and Security

İhsan Doğramacı Bilkent University

Ankara

February 2021

Dedicated to My Dear Family

ASYMMETRIC EFFECTS OF BENCHMARK PRICES ON IRAQI OIL:

BASRAH LIGHT, BASRAH HEAVY AND KIRKUK

The Graduate School of Economics and Social Sciences

of

İhsan Doğramacı Bilkent University

by

VOLKAN KAHRAMAN

In partial fulfillments of the Requirements for the Degree of

MASTER OF ARTS IN ENERGY ECONOMICS, POLICY & SECURITY

Graduate Program in

Energy Economics, Policy and Security

İhsan Doğramacı Bilkent University

Ankara

February 2021

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Energy Economics, Policy & Security.

Supervisor: Prof. Dr. M. Hakan Berument

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Energy Economics, Policy & Security.

Examining Committee Member: Prof. Dr. Nükhet Doğan

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Energy Economics, Policy & Security.

Examining Committee Member: Assoc. Prof. Fatma Taşkın

Approval of Graduate School of Economics and Social Sciences

Director: Prof. Dr. Refet S. Gürkaynak

ABSTRACT

ASYMMETRIC EFFECTS OF BENCHMARK PRICES ON IRAQI OIL: BASRAH LIGHT, BASRAH HEAVY AND KIRKUK

Kahraman, Volkan

M.A. Program in Energy Economics, Policy and Security

Supervisor: Prof. Dr. M. Hakan Berument

February 2021

This thesis assesses the asymmetric effects of benchmark oil prices on Basrah Light, Basrah Heavy and Kirkuk crude oil prices. The empirical evidence reveals that a decrease in benchmark prices decreases three Iraqi oil blends more than an increase in benchmark increases for three Iraqi blends. Moreover, as the magnitude of shocks to benchmarks increases, then the degree of asymmetry also increases.

Key Words: Crude oil prices; Benchmark prices; Asymmetric effects.

ÖZET

GÖSTERGE PETROL FİYATLARININ IRAK PETROLLERİNE ASİMETRİK ETKİLERİ:

BASRA LIGHT, BASRAH HEAVY VE KIRKUK

Yüksek Lisans, Enerji Ekonomisi ve Enerji Güvenliği Politikaları Programı

Kahraman, Volkan

Tez Danışmanı: Prof. Dr. M. Hakan Berument

Şubat 2021

Bu tez, gösterge petrol fiyatlarının Basra Light, Basrah Heavy ve Kerkük ham petrol fiyatları üzerindeki asimetrik etkilerini değerlendirmektedir. Ampirik kanıtlar, gösterge fiyatlarındaki düşüşün üç Irak petrol harmanını daha fazla düşürdüğünü, gösterge değerindeki artışın ise üç Irak harmanınıı artırdığını ortaya koymaktadır. Dahası, ölçütlere verilen şokların büyüklüğü arttıkça, asimetri derecesi de artmaktadır.

Anahtar Kelimeler: Ham petrol fiyatları; Gösterge fiyatları; Asimetrik etkiler.

ACKNOWLEDGEMENT

First, I would like to express my sincere gratitude to my supervisor and mentor Prof. Dr. M. Hakan Berument. With his vast knowledge throughout my graduate studies, he has always supported me for the next step, with constructive comments, patience, encouragement, never-ending knowledge of energy economy. Working with him was a great chance for me. He is exceptionally a good professor and researcher; also, he is the best person in his field with his great personality and endless energy. I believe that every subject I learned from him during my master's time will guide me through important milestones of my career. I am grateful to him for giving me the chance to work with him, always supporting me to develop my ideas and making it possible for me to get to this point.

I would like to thank to dear Serkan Şahin. When I asked him every question I had in mind, he explained it to me with determination, enthusiasm, and great kindness. I am grateful to him for the valuable ideas that he gave by keeping my morale high in all the problems I have experienced and for helping me to continue to the next stage without giving up. I follow his works with great admiration, and I look forward to having the opportunity to work with him in the same sector one day.

I am sincerely indebted to the generous support from Prof. Dr. Nükhet Doğan. She shared her ideas in the field of econometrics with me with great delicacy and ensured that my projects and thesis take the current form.

I would also like to express my gratitude to dear Ömer Berki, who always supported me during my undergraduate and graduate education. Thanks to his valuable ideas and opinions, he not only motivated me to write my thesis, but he is also one of the hidden heroes in the existence of my thesis.

I would like to thank Göktuğ Şahin for supporting me in the work I did during my thesis and for making it easier for me to progress with his knowledge.

I would also like to express my gratitude to Furkan Vefa Kurt. Because he supported me unconditionally with all his energy, knowledge and above all his friendship throughout our graduate study. His help has been truly significant for me both as a friendship and a colleague. I am happy that this friendship we have established in our graduate studies will continue in our social and academic life.

In this long marathon journey, I would like to express my sincere gratitude and pleasure to Simay Aydonat for her great joy, her huge smile, and her precious friendship, for always showing her support by being always with me. All this would just be boring and dull if it were not for her grateful personality.

Finally, I want to express my deepest gratitude to my family. I express my endless thanks to them for their unrequited love, inexhaustible support, patience, motivating me to stand up stronger every time I fall, and for every opportunity they offer me to do better. I would like to thank to my mother Filiz KAHRAMAN for providing continuous support and trust throughout my entire life and, I would like to thank my father Yakup KAHRAMAN for all his efforts to show the right path with his love, support, and knowledge.

LIST OF ABBREVIATIONS

OPEC: Organization of the Petroleum Exporting Countries

API: American Petroleum Institute

BOT: Al Basra Oil Terminal

KOT: Khor al-Amaya Oil Terminal

KRG: Kurdish Regional Government

NOCs: National Oil Companies

OSP: Official Selling Price

RSCI: Reuters Sour Crude Index

SOMO: Iraq's State Organization for Marketing of Oil

US CPI: United States Consumer Price Index

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Oil is one of the most important commodities that affects macroeconomics performances for all the countries. Approximately 80% of the proven oil reserves in the world belong to Organization of the Petroleum Exporting Countries (OPEC) member countries. Iraq has the fifth largest oil reserves of the world and is the second largest OPEC producer. Moreover, Iraqi economy, to be particular, the government revenues heavily depend on its oil revenues. Thus, understanding the dynamics of Iraqi oil prices is quite important for the world oil markets as well as the Iraqi economy. The purpose of this thesis is to understand the dynamic relationship between Iraqi crude oils and their reference (benchmark) prices. The empirical evidence reported here suggests that the negative oil price shocks on benchmark decreases the prices of Iraqi major blend Basrah Light and Kirkuk more than an increase in benchmark prices. The direction of the asymmetry is reverse for Basra Heavy compare to the other two blends. These clearly shows that Iraq cannot benefit from the oil price increases and market developments. Any remedy to eliminate this asymmetry will clearly benefit the Iraqi economy.

Each crude types of Iraq exports has a different demand pattern based on their export destinations and refinery configurations of the importing regions of a country. Thus, Iraq sets its oil prices by setting up a fixed price margin that is set for a month to a reference oil price (benchmark price) before the corresponding month.[1] The margin is set through its Official Selling Prices (OSP), for a month for Iraq's long-term customers depending on their geographic locations. These fixed price margins can be set positive or negative relative to benchmark oil price for the month.

A unified world oil market hypothesis assumes that there is a long-run relationship among all the oil prices beyond their physical, technical, political and monetary disruptions. Adelman (1984) examines the international oil transactions between Saudi Arabia and the United States by studying the political developments of these

---

[1]The value of any crude oil comes from a term "netback pricing" which is the theoretical reflection of buyer's refinery margin for that particular crude oil. Since the buyer is expected to hedge against the benchmark price, the price risk is minimized only on differential.

two countries from 1971 to 1980. He claims that Saudi Arabia prioritizes its economic interests to set the crude oil price, and this creates a common structure that affects the world oil market. Rodriguez and Williams (1993) examine whether there is a long-run relationship among major four crude blends: West Texas Intermediate (WTI), Brent blend (Brent), Alaskan North Slope and Dubai's Fateh (Dubai) benchmarks. They argue that there is a long-run relationship among those oil prices. Gülen (1997) examines relationship among prices of fifteen oil blends by considering their American Petroleum Institute (API) gravities[2], and sulfur content differentiations for the periods between 1980 and 1995. By applying the bivariate and multivariate versions of cointegration tests to the formed groups, he argues that oil types with the same quality content in different production regions do not differentiate from each others' prices. He claims that this supports the unified world oil market hypothesis. However, in his study, heavy crude oil prices do not move in the same direction. Fattouh (2010) studies crude petroleum price differentials by adopting a two-system threshold autoregressive process. He argues that even if there are two adjustment processes to the long-run equilibrium oil prices, then the existence of a long-run equilibrium support for the unified oil market hypothesis.

The producers and National Oil Companies are in fierce competition in the oil markets. They try to differentiate themselves to increase their market shares in different dimensions beside chemical characteristics of oils that they produce. Thus, this suggests that the Unified World Oil Market Hypothesis does not exist. Weiner (1991) studies the interactions between different oil types such as Nigerian Bonny Light, Saudi Light, United Kingdom Generic, Indonesia Generic and Soviet Urals in four separate regions from 1980:1 to 1987:4, he concludes that there is a significant level of regionalization. He suggests that the world oil market is far from being completely unified. The reason of this is that sellers can discriminate oil prices by adopting different calculation formulas depending on export destinations. Kaufmann and Banerjee (2014) also argue that the global oil market is not entirely unified; they claim that crude oil is regionalized because of differences in physical properties of crudes, country risks, geographical location, and OPEC membership. Jia, An, Fang, Sun, & Huang (2015) utilize an optimal wavelet analysis based on gray correlation

[2] API gravity is short for American Petroleum Institute gravity; it is used to measure the weight of petroleum fluids compared to water. If a liquid has an API gravity of more than 10, then it floats on water. If the API gravity of the liquid is less than 10, then it sinks.

between three distinctive benchmark oil prices and China-Daqing blend with one-to-one and many-to-one dynamics. The findings in the aforementioned study suggest a unified oil market is not present.

Above mentioned studies also report that oil prices follow an asymmetric behavior to world oil market benchmarks. Weiner (1991) argues that the use of several kinds of crude oil in different regions of the world causes oil producing countries to change their sale prices depending on the region they export. Moreover, Kaufmann and Banerjee (2014) argue that different factors such as crude oil specifications, being a member of OPEC, geographical factor, and the political structure of crude oil exporting country have an effect on oil prices and cause different pricing. To illustrate the consequences of the effects of different factors, Jia et al. (2015) also studies dynamic relationship between spot Chinese Daqing oil prices and a set of world benchmark oil prices. They also support the existence of the regional market for oil.

Overall, oil prices remain under the influence of global benchmark prices. However, the political structures of the major oil producer countries, being a part of organizations such as OPEC, which region that oil exported and the differences in export destinations for the produced oil also lead to price differences. Therefore, when determining oil prices, regional oil markets need to be considered, and the use different benchmarks in different regions are in order.

The asymmetric effect of benchmark prices on local prices is also suggested in the literature. There are various reasons for the asymmetry. The nature of production agreements between the Iraqi government and oil (upstream) companies and the inadequate storage facilities lead to the first source of asymmetry. Oil producing upstream firms mainly gather their revenues from their oil production with a fixed revenue regardless the price of the oil. Thus, both government and local producers like to sell as much as oil possible regardless of oil price. Importantly, Iraq has also limited storage capacity. Thus, when the demand is high, country may increase the Iraqi oil prices, yet when the demand is low Iraq must decrease oil prices more due to low storage capacity. Second, oil revenue constitutes the major source of income for Iraq and the main source of revenue for the government. As the oil prices are lower, government needs to sell more oil thus lower its OSP more to meet its fixed revenue needs. This suggest that Iraqi oil prices will be lower with higher oil supply to meet this fixed revenue needs and respond differently to increase versus decrease in world benchmark oil prices.

The *r*-factor is the third reason of asymmetry. Ahmadov, Artemyev, Aslanly, Rzaev, Shaban (2012) notes that *r*-factor is the proportion of aggregate receipts from the sale of petroleum to cumulative expenses. The fixed amount of oil production share payment that government makes for the extraction activities to upstream firms. Thus, the revenue that government collects is Sale Price less *r*-factor per barrel. X percent increase in sale price increases government revenues more than X percent, or if government like to increase its revenue by Y percent, oil prices should increase less than Y percent. This triggers the asymmetric response of oil prices to benchmark oil prices or government's oil revenue needs. The purpose of this thesis is to show that Iraq sets its oil prices such that increase in oil price as the benchmark oil prices increases are less than decrease in oil prices as the benchmark oil prices decreases. This clearly shows that Iraq cannot benefit from oil price fluctuations, any step to eliminate this inefficiency will benefit the Iraqi economy.

Outline of the thesis is as follows, in section 2, I introduce three types of Iraqi oils and their benchmarks specifications. In section 3, I discuss Iraqi oils and other competitors, in section 4 I discuss the data and introduce the econometric methodology for the assessment of asymmetry. In section 5, provides empirical evidence. In section 6, I present my results and offers conclusions.

CHAPTER II

THREE TYPES OF IRAQI OIL

Up to 90% of Iraq's proven oil reserves are located in onshore fields in the southern part of the country. The fields in this region are under the control of the Iraqi Federal Government. The remaining 10% of crude oil reserves are located in the northern part of the country and controlled particularly by the Kurdish Regional Government (KRG). Iraq has three different types of crude oil to be exported.[3] These are Basrah Light, Basrah Heavy and Kirkuk crude oils. Basrah light is the main export blend of oil for the country. This is followed by Basrah Heavy and Kirkuk crude oils. China, India, South Korea, The United States, and the Italy are the top five countries that exports Iraq's crude oil exports in 2019. China imported 26.50% of Iraqi oil, India, South Korea, The United State, and Italy imported 25.03%, 8.10%, 7.86% and 6.25% respectively in 2019. Thus, Asia-based countries are the major buyers of Iraqi crude oil.

Iraq exports two Basrah Blends from country’s Southern Port of Basrah. Basrah Light and Basrah Heavy are sent out from the Al Basra Oil Terminal (BOT) and Khor al-Amaya Oil Terminal (KOT). Kirkuk blend is exported from Turkish Port Ceyhan via a Kirkuk-Ceyhan Oil Pipeline. Basrah Light, and Basrah Heavy have different physical properties and thus have different product yields, refinery processing costs, technical challenges, and buyer patterns. Basrah Light grade has a higher API and a lower Sulphur than Basrah Heavy. API for Basrah Light is 33° and Basrah Heavy is 26.4°. Sulphur is 2.85% for Basrah Light and 4.12% for Basrah Heavy. These differences are reflected on their pricing mechanisms triggered from different demand patterns that also explains why one may observe different asymmetric patterns for two crude blends produced in the same region and exported from the same port. Note that prices of crudes oil are determined by the margins of the oil products refined from that crude oil. For Basra Heavy, it can be thought that the market conditions are limited than other Iraqi oil types, due to its lower API and higher sulphur content. Less preferred oil will have a higher amount of demand increase under higher world crude demand. Thus, one may expect higher benchmark

[3] Iraq introduces another type of oil starting to shipment January 2021: Basrah Medium. Since I do not have enough observation for this oil blend, I could not incorporate this blend into my analyses.

crude oil price increase affect more the Basrah Heavy prices than benchmark crude oil price decreases.

Kirkuk crude oil blend has 35° API and 2.4% Sulphur rate; its lighter and sweeter than both Basrah blends. Kirkuk crude oil produced from three different blocks in the northern part of the country. These blocks are Khurmala Dome, Avana Dome, Baba Dome. Avana Dome, and Baba Dome blocks belongs to the Iraqi Federal Government. Khurmala Dome belong to the KRG. The operational responsibility of Kirkuk crude oil belongs to KRG, but various other rights are held by the Federal Administration. Both KRG and the Federal Administration produce the Kirkuk Blend. While KRG is responsible for carry out shipping, sale, and determination of buyers of Kirkuk blend, Iraq's State Organization for Marketing of Oil (SOMO) determines the price of Kirkuk blend and allocating revenue from exports between the KRG and the Federal Administration. One of the reasons why Iraqi oil is exported from the Turkish Ceyhan port is cost of shipping; shipment to Basrah port would be more costly. Secondly, the Strait of Hormuz and the Suez Canal are bypassed with the export of Kirkuk crude oil from Ceyhan port; the Ceyhan port provides a direct access to the Mediterranean.

Official sale price is an important element for crude oil exports. National Oil Companies (NOCs) set a fixed price margin relative to a benchmark for each region they sell oil to. These fixed margins are generally set for a month by each NOCs after a formal meeting. These fixed margins are set by SOMO to determine OSPs for all Iraqi blends for each month. Brent and Dubai are the most broadly utilized benchmarks worldwide; however, the Dubai price is one of the main reference prices for crude oil shipped from the Middle East to Asia since the 1980s. Iraqi uses Brent for its European crude oil shipments, Oman/Dubai for its Asian shipments, and Argus Sour Crude Index for American shipments for all three blends that it exports.

CHAPTER III

IRAQI OIL AND OTHER COMPETITORS

Although, Iraq is one of the major oil exporters in the world and among OPEC, this does not prevent the country from facing a fierce competition for its market share. Especially with its OPEC allies; Iran, Kuwait, Saudi Arabia, and the United Arab Emirates are its major competitors. Asia has been the key region to drive global oil demand. Nearly, all major oil producers are in intense competition to keep or increase their market shares in Asia. This is one of the main conflicting interest among OPEC members as they all want to attain a higher market share in Asia while trying to keep OPEC as a working alliance against their non-OPEC counterparts. Saudi Arabia, being the largest producer and exporter, is the main country to drive the pricing mechanism for crude oil exported from the Middle East to Asia. In other words, Saudi Arabia's Asian OSPs for its crude grades is the main price setter for all other Middle Eastern crude oil shipped to Asian markets.

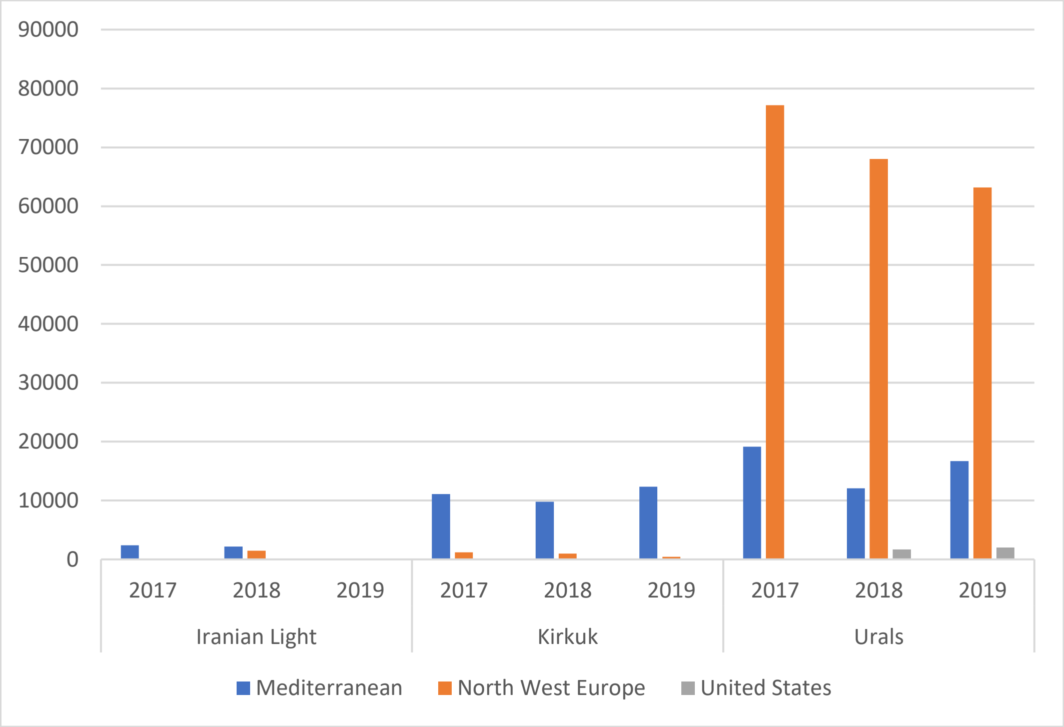
Saudi Arabia's main export grade, Arabian Light, is a direct competitor against Iraqi Basrah Light. This forces Basrah Light price to converge into Arabian Light prices instead of following its own dynamics. Basrah Light needs to adjust its OSP against Arabian Light in order to find buyers and it can be an additional factor in determining the OSP as well as the benchmark price. Thus, as both crude grades prices relative to Dubai benchmark for Asian OSPs, Basrah Light's OSP generally set lower against Arabian Light's OSP to have an advantage in sales.

Basrah Heavy also competes with other Middle Eastern crude grades for its market share but the lower API grade and higher sulphur are its major disadvantages. Higher API simplifies refining process but high sulphur content is an undesired specification in oil the market which increases transportation and refining costs, as well as harms the equipment during shipment and refining of the crude oil. Basrah Heavy, with increasing total volume, must incorporate these costs and potential risks for its buyers in order to find a buyer in the market. This results with a more than desired discount for the crude grade with potential financial losses for the Iraqi government. During high demand periods, despite its physical disadvantages, thanks to its large export capacity, Basrah Heavy can find sizable buyers in the market, especially in

Europe and Asia where refineries can handle high sulphur relatively more successfully. It is likely that Iraqi government tend to increase its Basrah Heavy OSPs more than the increase in their benchmarks in strong demand periods to cover the losses due to abovementioned deductions in low demand periods. This may lead to a different asymmetric pattern for Basrah Heavy than Basrah Light and Kirkuk.

Potential competitors of Kirkuk crude oil are Urals and Iranian Light. The export destination of Kirkuk crude oil is Europe and the USA. Ceyhan provides an advantage for the blend to be sold to Mediterranean and USA since this type of Iraqi oil does not need to passthrough the Strait of Hormuz and the Suez Canal. However, terrorist attacks on the production facilities and Kirkuk-Ceyhan pipeline may causes supply distributions and this lead the Kirkuk blend to be priced lower.

Figure 1: Export Destinations of Kirkuk Crude Oil and its Competitors in 2017-2019



Source: Eikon Refinitiv

CHAPTER IV

DATA AND METHODOLOGY

The monthly data is employed from October 2002 for Basra Light, Kirkuk blends and April 2015 for Basra Heavy. The latter date for Basrah Heavy is due to the introduction of the blend. The sample is ended in October 2019 in order to eliminate the effect of the COVID-19 Pandemic. Benchmark prices and Iraqi oil prices data are gathered from Eikon Refinitiv. The price data of Iraqi oil prices and benchmark prices are divided by the United States Consumer Price Index to convert into real terms. The data is obtained from Federal Reserve Bank of St. Louis (FRED data delivery system). Three different benchmarks depending on their export destinations are employed: Dated Brent (DBrent) is used for all European sales for all the three blends. For Asia sales is Oman/Dubai, is used as benchmark. The Argus Sour Crude Index used the for the United States (US) sales by SOMO, yet since this data is not readily available, the Reuters Sour Crude Index (RSCI) data has been used as a benchmark for the US sales in my analyses.

To analyze the dynamic asymmetrical relationship between each of Iraqi blend prices and benchmark oil prices in the study the Kilian and Vigfusson's (2011) methodology is used. The nonlinear VAR (*n*) specification adopted is the following:

$$y_t = \beta_{10} + \sum_{k=1}^{n} \beta_{11,k} y_{t-k} + \sum_{k=1}^{n} \beta_{12,k} x_{t-k} + \varepsilon_{1,t} \tag{1.a}$$

$$x_t = \beta_{20} + \sum_{k=0}^{n} \beta_{21,k} y_{t-k} + \sum_{k=1}^{n} \beta_{22,k} x_{t-k} + \sum_{k=0}^{n} \gamma_{21,k} y_{t-k}^{+} + \varepsilon_{2,t}, \tag{1.b}$$

where t = 1, 2, …, T.

Here, y_t is the percentage change in benchmark oil price and x_t is for is the percentage changes is different types of Iraqi oil prices that I consider, ε_t is the mean zero sequentially uncorrelated error term at time *t*, and *n* is the lag order. Note that equation (1.a) is a standard (symmetric) linear model both in y_t and x_t, while equation (1.b) includes benchmark oil price changes, Iraqi oil type price changes, (y_t), and the censored variable of y_t at the same time. The censored variable y_t^+ is for the positive changes in benchmark oil price that is be defined as

$$y_t^+ = \begin{cases} y_t, & if\ y_t > 0 \\ 0, & if\ y_t \leq 0 \end{cases} \tag{2}$$

β_{10} and β_{20} are for the intercept terms in the benchmark oil price specification and Iraqi crude oil price specification, respectively. $\beta_{11,k}$ and $\beta_{12,k}$ are for the estimated coefficients of the lag values of the benchmark oil prices and the Iraqi crude prices in the benchmark oil specification. $\beta_{21,k}$ and $\beta_{22,k}$ are for the estimated coefficients of lagged values of the benchmark oil prices and Iraqi crude prices in the Iraqi crude oil price specification. Last, $\gamma_{21,k}$ are for the estimated coefficients of the censored variable in the Iraqi crude oil price specification.

Data on orthogonalized shocks to the variables using the Cholesky decomposition is gathered from the equation (1.a) and (1.b) for the identification. The nonlinear impulse responses are gathered the Kilian and Vigfusson (2011) methodology. I assume that benchmark crude oil prices affect Iraqi crude blends but not vice versa contemporaneously. However, all the variables affect each other with a lag.

In order to test the asymmetry, first, I test $H_0 : \gamma_{21,0} = \cdots = \gamma_{21,n} = 0$ in equation (1.b). It has a χ^2_{n+1} distribution under the null hypothesis.

Second, I used Kilian and Vigfusson's (2011) impulse response-based test for the asymmetry. Note that the impulse responses are a non-linear model and also history dependent and the magnitude of shocks changes the slope of the impulse response function (see, for example Berument, Yalcin, and Yildirim, 2011). Thus, these tests are performed for 1-SD and 2-SD shocks that I test if $I_y(h, \delta) = -I_y\,(h, -\delta)$ or $I_y(h, \delta) + I_y(h, -\delta) = 0$ where *h* is the response period *h* = *1, 2, …, H* and δ is the magnitude of introduce shock such as 1-SD or 2-SD shocks.

CHAPTER V

EMPIRICAL ESTIMATES

The Kilian and Vigfusson's (2011specification is estimated with two lags as suggested Bayesian information criteria for the analyses. Panel A of Table 1 reports the Slope Based test for asymmetry; thus, I tested all the coefficients of $\{y_{t-i}^{+}\}_{i=0}^{n}$ are join to be zero. For all the export destinations and for all the Iraqi oil blends, I reject the null of symmetry decisively. Panel B also reports the impulse-response based test for 1-SD and 2-SD shocks.[4] Even if the statistical evidence weaker for the latter asymmetry tests, the symmetry is clearly rejected for the Iraqi major oil blend (Basrah Light) for its major export destination (Far East). Thus, I claim that the effects of benchmark oil prices on Iraqi crude prices are asymmetric.

As elaborated in the methodology, due to asymmetry, I report the impulse responses of three Iraqi crude blends to benchmark prices positive and negative oil prices shocks by different 1-, 2-, 4-, and 10- standard deviation shocks in the Figures 2 to 4. These impulses are reported for 12 periods. The solid black lines are for a positive benchmark price shock, where the dotted lines are for negative price shocks. However, in order to compare the magnitudes, I report the inverse (negative) of negative benchmark shocks.

Figure 2 reports that impulse responses of a positive and a negative shocks of the benchmarks of oil prices and affect three different kinds of Basrah Light oil prices according to their export destinations. *Basrah Light E* is for Basrah light’s European destination, *Basrah Light US* for its US destination and *Basrah Light FE* is for its Asian destination. *Basrah Light E* uses the *DBrent* as its benchmark price, while *Basrah Light US* uses the *RSCI* as its benchmark price and *Basrah Light FE* uses the *Oman/Dubai* as its benchmark prices.

[4] also perform the 4-SD and 10-SD shocks-based tests. The results are reboots yet; they are reported in the Appendix.

Table 1: Testing Symmetry in Oil Price Increases and Decreases

	Basrah Light E		*Basrah Light FE*		*Basrah Light US*		*Basrah Heavy E*		*Basrah Heavy FE*		*Basrah Heavy US*		*Kirkuk E*		*Kirkuk US*	
Panel A: Slope Based Test [Test Statistics]																
Wald Test	6358.2**		5693.5**		31645.0**		5035.3**		11102.0**		28589.7**		18969.0**		84982.6**	
Panel B: Impulse Response Based Test [*P*-values]																
Period	*1-SD Shock*	*2-SD Shock*	*1-SD Shock*	*2-SD Shock*	*1-SD Shock*	*2-SD Shock*	*1-SD Shock*	*2-SD Shock*	*1-SD Shock*	*2-SD Shock*	*1-SD Shock*	*2-SD Shock*	*1-SD Shock*	*2-SD Shock*	*1-SD Shock*	*2-SD Shock*
0	0.778	0.615	0.131	0.100	0.793	0.042*	0.393	0.192	0.220	0.143	0.657	0.105	0.749	0.161	0.887	0.204
1	0.182	0.259	0.048*	0.004**	0.166	0.097	0.694	0.426	0.322	0.294	0.875	0.267	0.014*	0.041*	0.362	0.417
2	0.258	0.369	0.006**	0.000**	0.168	0.173	0.672	0.619	0.088	0.237	0.524	0.419	0.036*	0.091	0.291	0.431
3	0.402	0.533	0.005**	0.000**	0.282	0.256	0.817	0.775	0.088	0.310	0.685	0.571	0.069	0.156	0.422	0.523
4	0.545	0.676	0.009**	0.000**	0.396	0.354	0.904	0.877	0.111	0.338	0.809	0.710	0.120	0.247	0.526	0.651
5	0.672	0.789	0.017*	0.000**	0.514	0.477	0.954	0.937	0.175	0.410	0.892	0.816	0.188	0.354	0.650	0.766
6	0.776	0.870	0.024*	0.001**	0.631	0.593	0.979	0.969	0.225	0.342	0.942	0.888	0.270	0.462	0.757	0.851
7	0.848	0.920	0.040*	0.001**	0.728	0.688	0.991	0.986	0.309	0.438	0.971	0.935	0.363	0.570	0.837	0.909
8	0.905	0.954	0.063	0.002**	0.810	0.776	0.996	0.994	0.386	0.523	0.985	0.964	0.458	0.669	0.896	0.948
9	0.942	0.975	0.092	0.004**	0.870	0.841	0.999	0.997	0.478	0.614	0.993	0.981	0.553	0.754	0.933	0.967
10	0.966	0.987	0.130	0.006**	0.915	0.893	0.999	0.999	0.560	0.695	0.996	0.990	0.642	0.822	0.958	0.981
11	0.981	0.994	0.177	0.010*	0.947	0.928	1.000	1.000	0.644	0.768	0.998	0.995	0.721	0.876	0.976	0.990

Notes: In Panel B, *p*-value based on 1 000 simulations of model χ^2_{H+1} value.

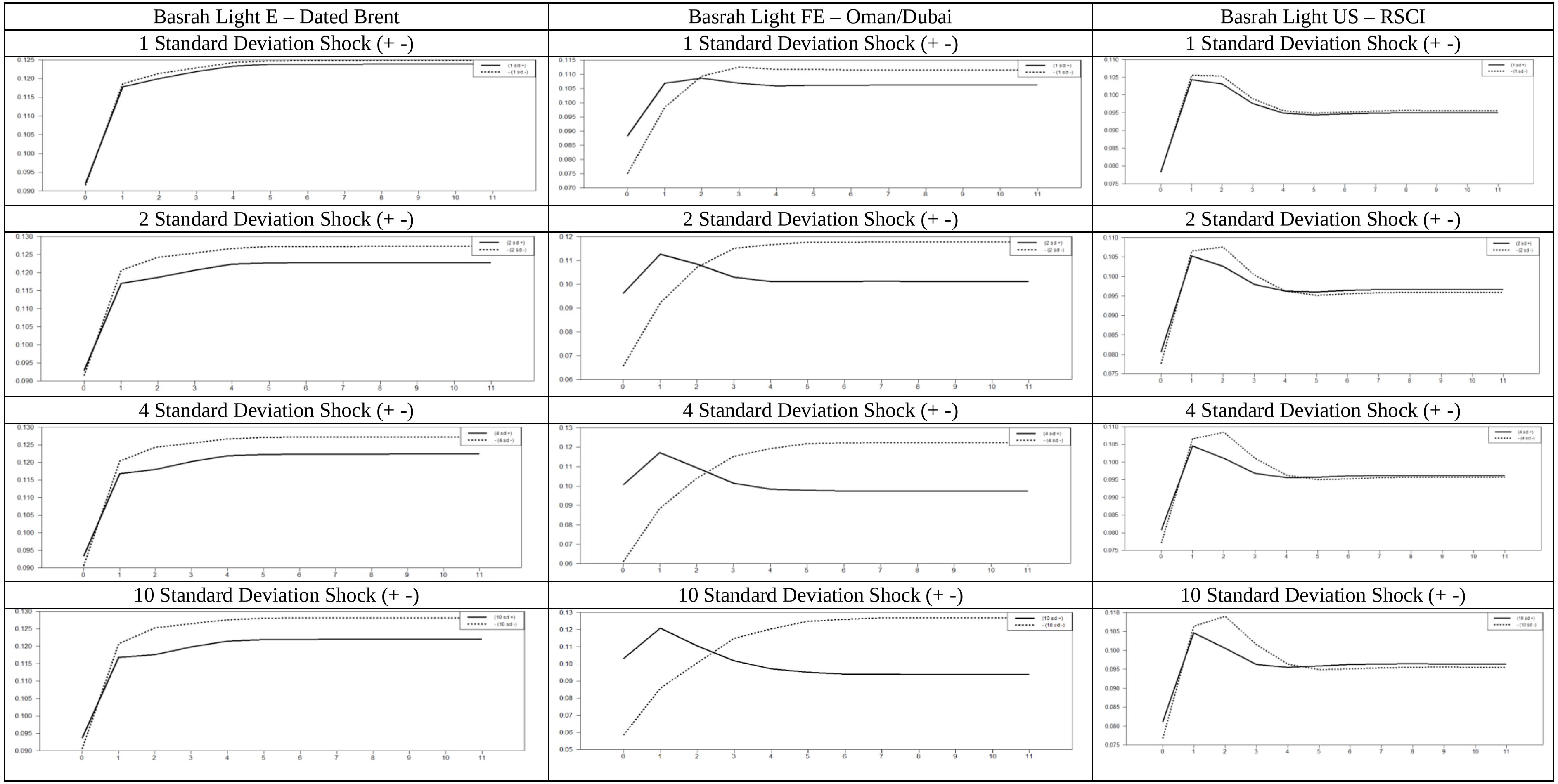
**; indicates the level of significance at 1%.

* ; indicates the level of significance at 5%.

The response of *Basrah Light E* to negative 1-, 2-, 4- and 10- SD shocks of *DBrent's* is greater than their positive shocks for all the periods. After the first period, the positive and negative shocks move in the opposite direction, but as the shock magnitude increases, the difference between positive and negative gradually increases. However, I could not find similar statistically significant evidence for *Basrah Light E.* Once, 1-, 2-, 4- and 10- SD shocks are given to *Oman/Dubai*, the effect of negative shocks are greater than positive shocks for *Basrah Light FE*. The effects of negative shocks for *Basrah Light FE* are observed in the initial level only for 4- and 10-SD shocks. Impulse responses change the direction the effects and these effects are statistically significant for both 1-SD and 2-SD shocks at 5% and 1% levels. For *Basrah Light US*, the effects of 1-SD positive and negative to *RSCI* benchmark price, the negative shock has higher effect on prices compared to the positive shock for all periods that I consider. However, for the 2-, 4-, and 10- SD shocks, the effects of negative shocks are higher than positive shocks after the first period until the 4^{th} period. After the 4^{th} period, magnitude of shocks changes the direction. The effects of positive shocks are greater than negative shocks.

Figure 3 reports that impulse responses of a positive and a negative shocks to the benchmarks of oil prices and effects of three kind of Basrah Heavy oil prices depending to their export destinations. *Basrah Heavy E*, *Basrah Heavy FE* and *Basrah Heavy US* with benchmarks of *DBrent*, *Oman/Dubai* and *RSCI*, respectively.

Figure 2: Responses of Basrah Light Prices to Positive and Negative Benchmark Oil Price Shocks by Different Shock Sizes



In the first column of the Figure 3, 1-, 2-, 4- and 10- SD positive and negative shocks give to *DBrent* prices, effects of the positive shocks on *Basrah Heavy E* for all periods are greater than the negative shocks and the difference increases with the magnitude of shocks. While there is a rapid increase (decrease) in the first period. After the 1st period, then the rapid increase (decrease) with positive (negative) shocks continue to decrease until the 3rd. In the second column the effects of *Oman/Dubai* price shocks on *Basrah Heavy FE* are examined. Similar to Dated Brent shocks, positive benchmark shocks increases Basrah Heavy prices more than negative benchmark shocks decreases Basrah Heavy prices. Moreover, higher the magnitude of shocks, higher the asymmetry. The effects on *Basrah Heavy US* prices are examined in the third column of Figure 3, the estimates are reboot with the estimates in the first two column. Note that even if slope-based test decisively reject the null of symmetry, impulse response-based test cannot reject the null of symmetry. For Basrah Light and Kirkuk blends both slope-based Test is statistically significant at 5% and Impulse-Response Based test results for 1-SD and 2-SD shocks reject the null of symmetry. One reason for this is that my sample starts later, and I do not have long data points for Basrah Heavy. Even if its high sulphur content and thus less desirability, due to their refinery configurations, Basrah Heavy has import customers in Asian and European refineries. As the world oil demand increases, demand for Basrah Heavy and its prices increases more. This may lead to a different asymmetry pattern for Basrah Heavy than Basrah Light.

Figure 3: Responses of Basrah Heavy Prices to Positive and Negative Benchmark Oil Price Shocks by Different Shock Sizes

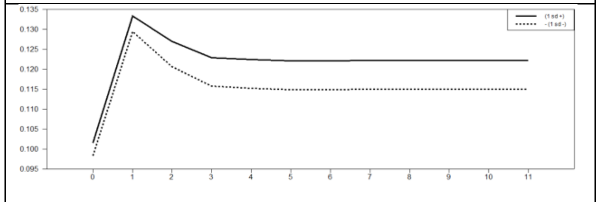
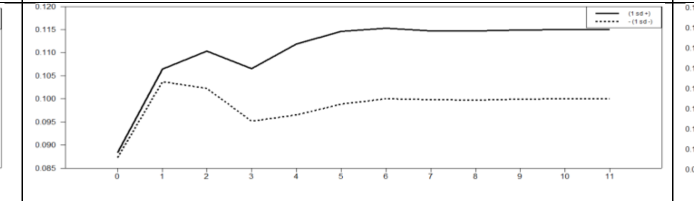
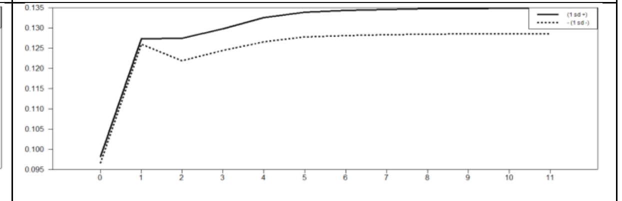
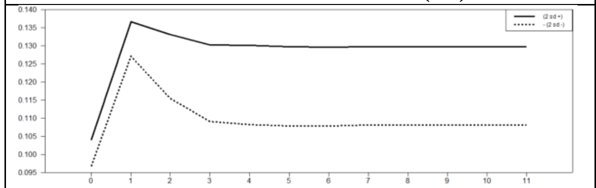
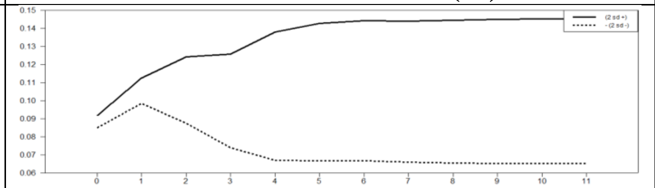
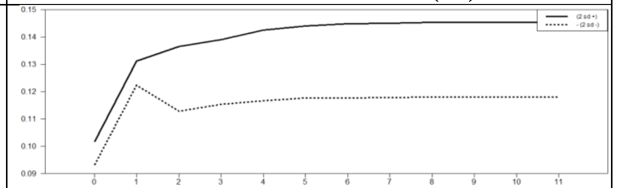
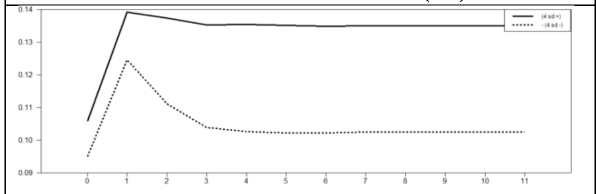
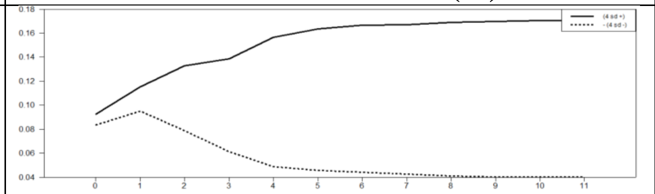
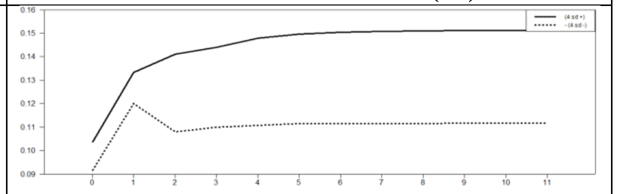
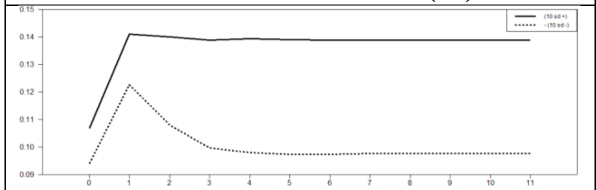
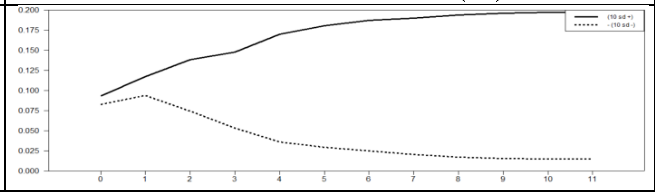
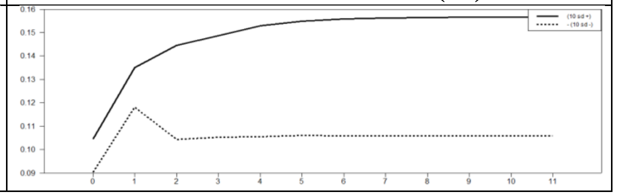
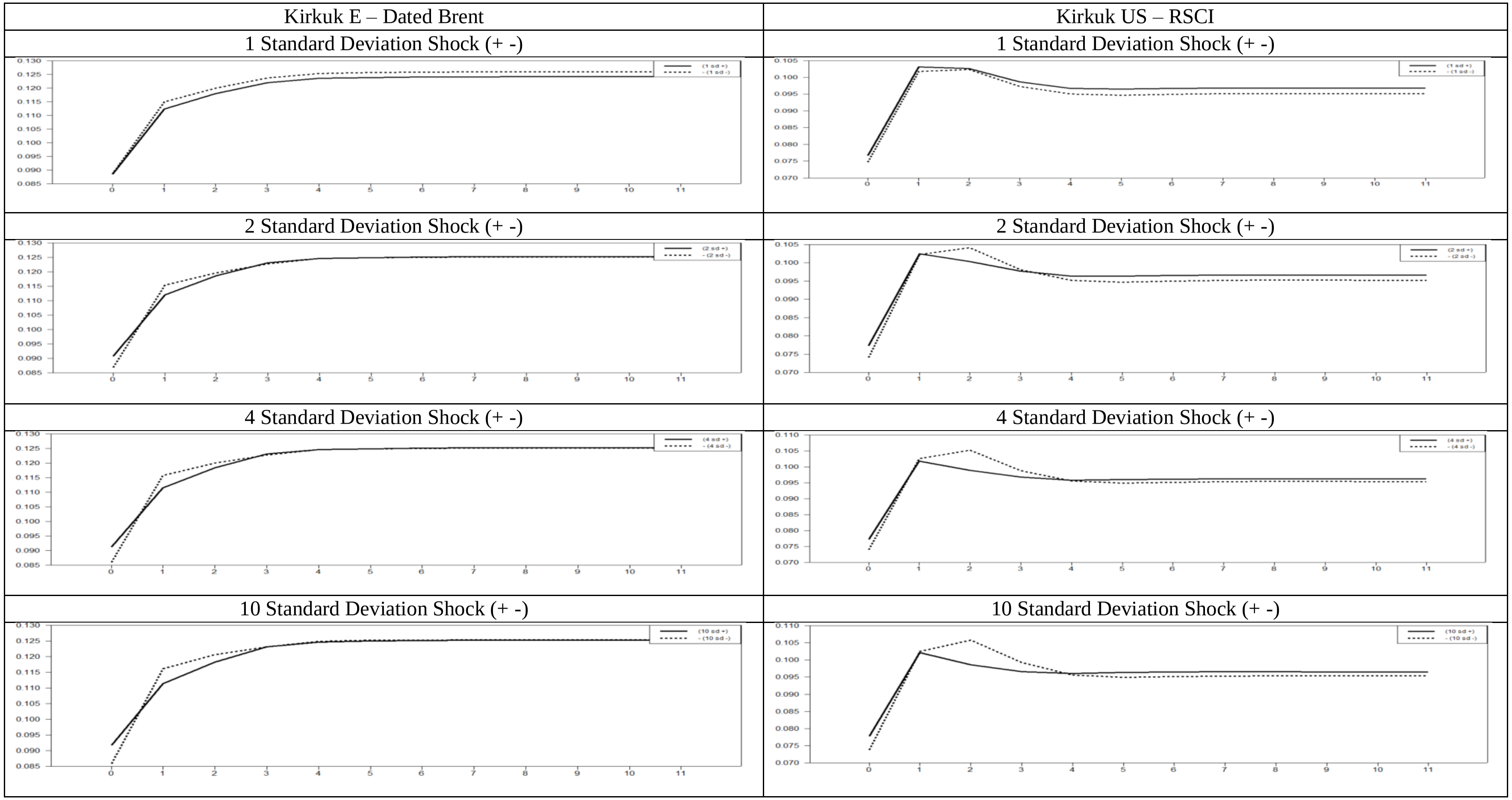
Basrah Heavy E – Dated Brent	Basrah Heavy FE – Oman/Dubai	Basrah Heavy US – RSCI
1 Standard Deviation Shock (+ -)	1 Standard Deviation Shock (+ -)	1 Standard Deviation Shock (+ -)
		
2 Standard Deviation Shock (+ -)	2 Standard Deviation Shock (+ -)	2 Standard Deviation Shock (+ -)
		
4 Standard Deviation Shock (+ -)	4 Standard Deviation Shock (+ -)	4 Standard Deviation Shock (+ -)
		
10 Standard Deviation Shock (+ -)	10 Standard Deviation Shock (+ -)	10 Standard Deviation Shock (+ -)
		

Figure 4 reports the effect of a positive and a negative shocks to the benchmarks of oil prices on Kirkuk oil. Two destinations are considered for Kirkuk; European (*Kirkuk E*) and US (*Kirkuk US*). Their respective benchmarks are *DBrent* and *RSCI*, respectively.

The first column of Figure 4 shows the response of *Kirkuk E* to 1-, 2-, 4- and 10- SD shocks are given to *DBrent* price. The negative shocks to *DBrent* decreases *Kirkuk E* more than a positive shocks to *DBrent* increases *Kirkuk E* after the first period. As for the previous analyses reveal, the degree of asymmetry increases with the magnitude of shocks. However, after the third period the degree of asymmetry decreases. In the second column of Figure 4, the effects of positive and negative shocks to *RSCI* on *Kirkuk US* are assessed. When 1-SD shock is given to the *RSCI* prices, the effects of positive shock is greater than the negative shock. However, when 2-, 4, and 10-SD shocks are given, the effect of negative shock is bigger than positive shocks between the 2^{nd} and 4^{th} period. These effects are statistically significant with the slope-based test. Yet this effect is also statistically significant for the European deliveries for Europe between 2^{nd} and 4^{th} period.

Figure 4: Responses of Kirkuk Oil Prices to Positive and Negative Benchmark Oil Price Shocks by Different Shock Sizes



CHAPTER VI

CONCLUSION

In this thesis, I examine the asymmetric relationship between the three different oil types of Iraq, which are Basrah Light, Basrah Heavy and Kirkuk blend, and their benchmarks. For this, I utilized monthly data from October 2002 for Basra Light, Kirkuk blends and April 2015 for Basra Heavy. I end the sample October 2019 to eliminate of the effect of the COVID-19 Pandemic. Three different benchmarks are used depending on their export destinations. Dated Brent, Oman/Dubai and Reuters Sour Crude Index benchmarks depending on the export destinations of each Iraqi oil blends.

Impulse responses of Basrah Light prices to positive and negative its benchmark prices suggest that positive shocks increases Iraqi oil prices less than negative shocks decreases. Moreover, as the magnitude of shock increases, the degree of asymmetry increases. The supporting statistically significant evidence is stronger for the Asian deliveries than European deliveries. The asymmetric behavior of Kirkuk oil of the positive and negative behavior is similar to Basrah Light. However, the asymmetric behavior of Basrah Heavy is the reverse.

When the price dynamics of Basrah Light, Basrah Heavy and Kirkuk oils are compared with the benchmark prices, they are exported from different locations, they face different demand and supply dynamics, and they have different chemical characteristics. The asymmetric behavior of Basrah Heavy is different from than the other Iraqi blends. Basrah Heavy has one major disadvantage of quality, that is its high sulfur content. The high sulfur content is an undesirable feature in the oil market, it increases shipping and refining costs. Moreover, damaging equipment during the transportation and refining of crude oil. Thus, Basrah Heavy's position in the crude oil market is limited compared to the positions of Basra Light and Kirkuk oils. Due to this limit and the lower demand, Basrah Heavy priced lower compared to the other Iraqi oil blends. Therefore, higher demand effects Basrah Heavy more than other. Thus, one may expect and that is what we found, the asymmetric pattern of Basrah Heavy different than the other two Iraqi blends.

There are various reasons of the asymmetry. The political structure of Iraq, the characteristics of the types of oil it produces, export destinations of these oils, the production and transportation costs, and the refinery production procedures of importing destinations are the main reasons of this asymmetry. The existence of this asymmetry for Iraqi major exporting blend Basrah Light and Kirkuk is definitely against Iraqi interest. Thus, any policy to eliminate this asymmetry will benefit Iraqi public. Increased inventory capacity, less reliance of oil revenue for public spending and decreasing the effects of supply disturbances are among the ones Iraqi government can adopt.

REFERENCES

Adelman, M. A. (1984). International Oil Agreements. *The Energy Journal*, 5(3), 1-9.

Ahmadov, I., Artemyev, A., Aslanly, K., Rzaev, I., Shaban, I. (2012). How to scrutinise a Production Sharing Agreement: A guide for the oil and gas sector based on experience from the Caspian region. *International Institute for Environment and Development (IIED)*, London.

Fattouh, B. (2010). The Dynamics of Crude Oil Price Differentials. *Energy Economics*, 32, 334 -342.

Gülen, S.G. (1997). Regionalization in the World Crude Oil Market. *The Energy Journal*, 18(2), 109-126.

Berument, M.H., Yalcin, Y. & Yildirim, J.O. (2011). The inflation and inflation uncertainty relationship for Turkey: a dynamic framework. *Empirical Economics, 41*, 293–309.

Jia, X., An, H., Fang, W., Sun, X. & Huang, X. (2015). How do correlations of crude oil prices co-move? A grey correlation-based wavelet perspective. *Energy Economics*, 49, 588-598.

Johansen, S. (1988). Statistical Analysis of Co-integration Vectors. *Journal of Economic Dynamics and Control*, 12, 231-54.

Kaufmann, R.K. & Banerjee, S. (2014). A Unified World Oil Market: Regions in Physical, Economic, Geographic, and Political Space. *Energy Policy*, 74, 235-242.

Kilian, L., &Vigfusson, R. J. (2011). Are the Responses of the U.S. Economy Asymmetric in Energy Price Increases and Decreases? Are Responses of the U.S. Economy Asymmetric? *Quantitative Economics*, 2 (3): 419–453.

Rodriguez, A.E., & Williams, M. D. (1993). Is the World Oil Market One Great Pool? A Test. *Energy Studies Review*, 5(2), 121-30.

Weiner, R. J. (1991). Is the World Oil Market One Great Pool? *The Energy Journal*, 12(3) 95-107.

APPENDIX

Completeness Report

To expand my study to better understand the effects of 4 and 10 SD shocks. The results have been reached are given in the table below.

	Basrah Light E		*Basrah Light FE*		*Basrah Light US*		*Basrah Heavy E*		*Basrah Heavy FE*		*Basrah Heavy US*		*Kirkuk E*		*Kirkuk US*	
Panel A: Slope Based Test																
Wald Test	6358.2^{**}		5693.5^{**}		31645.0^{**}		5035.3^{**}		11102.0^{**}		28589.7^{**}		18969.0^{**}		84982.6^{**}	
Panel B: Impulse Response Based Test																
Period	*4-SD Shock*	*10 -SD Shock*	*4-SD Shock*	*10 -SD Shock*	*4-SD Shock*	*10 -SD Shock*	*4-SD Shock*	*10 -SD Shock*	*4-SD Shock*	*10 -SD Shock*	*4-SD Shock*	*10 -SD Shock*	*4-SD Shock*	*10 -SD Shock*	*4-SD Shock*	*10 - SD Shock*
0	0.488	0.491	0.110	0.112	0.015^{*}	0.016^{*}	0.195	0.187	0.165	0.160	0.080	0.073	0.096	0.098	0.110	0.113
1	0.234	0.238	0.002^{*}	0.001^{**}	0.051^{*}	0.052^{*}	0.431	0.417	0.353	0.350	0.212	0.198	0.047^{*}	0.049^{*}	0.279	0.284
2	0.345	0.347	0.000^{**}	0.000^{**}	0.110	0.113	0.625	0.617	0.324	0.389	0.370	0.354	0.105	0.109	0.337	0.339
3	0.505	0.508	0.000^{**}	0.000^{**}	0.141	0.141	0.779	0.773	0.458	0.545	0.519	0.504	0.188	0.195	0.390	0.393
4	0.650	0.653	0.000^{**}	0.000^{**}	0.202	0.200	0.875	0.873	0.571	0.688	0.664	0.647	0.290	0.300	0.530	0.535
5	0.767	0.769	0.000^{**}	0.000^{**}	0.297	0.292	0.936	0.934	0.536	0.536	0.779	0.764	0.402	0.414	0.655	0.662
6	0.853	0.855	0.000^{**}	0.000^{**}	0.400	0.388	0.967	0.963	0.427	0.401	0.860	0.848	0.506	0.515	0.760	0.762
7	0.904	0.905	0.000^{**}	0.000^{**}	0.506	0.489	0.985	0.983	0.508	0.383	0.917	0.908	0.614	0.623	0.841	0.836
8	0.939	0.940	0.000^{**}	0.000^{**}	0.603	0.587	0.993	0.992	0.607	0.451	0.953	0.947	0.709	0.716	0.900	0.894
9	0.966	0.966	0.001^{**}	0.000^{**}	0.689	0.679	0.997	0.997	0.671	0.533	0.974	0.971	0.788	0.795	0.938	0.934
10	0.981	0.981	0.001^{**}	0.001^{**}	0.767	0.757	0.999	0.999	0.741	0.619	0.987	0.984	0.851	0.857	0.963	0.960
11	0.990	0.990	0.002^{*}	0.001^{**}	0.831	0.823	1.000	0.999	0.758	0.592	0.993	0.992	0.899	0.903	0.979	0.977

Notes: In Panel B, *p*-value based on 1 000 simulations of model χ^2_{H+1} value.

**; indicates the level of significance at 1%.
* ; indicates the level of significance at 5%.