Accepted Manuscript

Subject of manuscript

The Effect of Oil Supply Shock on Global Economy: Two OPEC Oil Giants

Elham Gholampour [1], Teymour Mohammadi[2], Asghar Abolhasani hastiani[1], Mohsen Mehrara [3]

1. Faculty of Economics, Payam-e-Noor University, Iran

2. Faculty of Economics, Allame Tabatabai University, Tehran, Iran

3. Faculty of Economics, Tehran University, Tehran

IranDoi: 10.22099/ijes.2023.43619.1838

To appear in: Iranian Journal of Economic Studies

Received Date: 26 May 2022

Revised Date: 27 December 2022

Accepted Date: 07 January 2022

Please cite this article as:

Gholampour, E., Mohammadi, T., Abolhasani hastiani, A., & Mehrara, M. (2023). The Effect of Oil Supply Shock on Global Economy: Two OPEC Oil Giants. Iranian Journal of Economic Studies, (), -. doi: 10.22099/ijes.2023.43619.1838

The Effect of Oil Supply Shock on Global Economy: Two OPEC Oil Giants

Elham Gholampour[1a] , Teymour Mohammadi[b], Asghar Abolhasani hastiani[a], Mohsen Mehrara[c]

a. Faculty of Economics, Payam-e-Noor University, Iran
b. Faculty of Economics, Allame Tabatabai University, Tehran, Iran
c. Faculty of Economics, Tehran University, Tehran

Abstract

This paper primarily focuses on the global macroeconomic consequence, which are the result of country-specific oil supply shocks using the GVAR-Oil model estimated for 27 countries/regions over the 1979Q2-2019Q4 period. Not only does this approach include how shocks affect directly exposed countries but it also indicates the indirect results of shocks thanks to secondary or tertiary channels. Given the importance of Saudi Arabia and Iran in the world's oil supply, adopting this model facilitates the way in which oil supply shocks are examined in the country-specific context. Therefore, the results indicate different disruptions depending on which country is subject to the shock. In fact, this study shows that a negative shock to oil supply in Iran has relatively insignificant effects on the global economy compared with those of Saudi Arabia since it can be neutralized by the increase in Saudi Arabia oil production. A negative shock to the oil supply in Saudi Arabia, however, results in an increase in oil prices, which adversely affects GDP and financial market in general. In addition, this approach provides policymakers with more opportunities to cope with consequences, which are the result of Covid-19, sanctions, and war, for instance, in a wider range of countries as representatives of the global economy, and thus help them to make better strategic decisions.

Keywords: global economy; financial market; Global VAR (GVAR); Iran; Saudi Arabia; oil supply shocks

JEL classification: C32, D43, Q43

Highlights

- The GVAR permits to analyze both the direct and indirect effects of country-specific oil supply shocks.
- The oil supply shock is highly dependent on the country that caused the shock.
- A negative shock to Iran's oil supply has very little consequences on the world economy since it may be offset by a rise in Saudi Arabia's oil output.
- A negative shock to Saudi Arabia's oil supply leads to higher oil prices, which have a negative impact on the economy and financial markets in general.

[1] Email Address (Corresponding author): elham_gh44@yahoo.com

1. Introduction:

This paper is trying to investigate the impact of oil supply shocks resulting from Iran and Saudi Arabia on the global economy including areas related to oil prices, GDP, and financial markets. Nevertheless, a number of studies explored the impact of oil supply shocks on a few industrial member states of the Organization for Economic Co-operation and Development (OECD), the US in particular, leaving other countries with little, if any, investigation (Gately & Huntington, 2002; Hamilton, 2009; Kilian, 2008, 2009; Peersman & Van Robays, 2012).

Nonetheless, a different methodology was required to address small-scale country-specific oil supply shocks. To this end, originally suggested by Pesaran et al. (2004), the Global Vector Autoregressive (GVAR) approach paved the way for modelling interactions in a complex high-dimensional system by which capturing transmissions in a wide variety of channels has been

facilitated. For instance, Baumeister and Peersman (2013b), studied the Time-Varying effects of oil supply shocks on the US economy. Their findings explain why an oil production shortfall of the same magnitude is associated with a stronger response of oil prices and more severe macroeconomic consequences over time, while a similar oil price increase is associated with lower oil production and loss rate in the US production over the recent years. This study also shows that oil supply shocks account for a smaller fraction of real oil price variability indicating the more vital role of oil demand shocks. Despite the variability of this time, the overall aggregate effect of oil supply disruption on the US economy has been modest (Baumeister & Peersman, 2013b).

Although a large body of research has been focusing on oil supply shocks in general, utilizing the GVAR approach enabled us to shed light on the effects of country-specific oil supply shocks on the global economy. Cashin (2014) studied the differential effects of oil demand and supply shocks on the global economy by employing a Global-VAR model for 38 countries/regions over the period 1979Q2-2011Q2. The results indicate that the economic consequences of a supply-driven oil-price shock for economic activities are very different from those of the demand-driven oil prices for economic activities. Moreover, the economic consequences of supply-driven and demand-driven oil price shocks are varying for oil-importing countries compared to energy exporters.

Our research widens the extant literature in a number of ways:

Initially, analyzing interactions in the global economy in addition to other networks using GVAR is believed to be an effective way for leading policymakers to be better able to determine financial crises, as a result of sanctions, Covid-19 pandemic, natural disasters, and war, which in turn could bring the advantage of acting accordingly.

Secondly, considering the significant role of Saudi Arabia and Iran in exporting oil, accounting for 16.7% and 4.6% in average between 2004 and 2019 respectively, the existing study aims to solidify the outstanding impacts of these two countries on both advanced and emerging economies.

Thirdly, unlike most studies, which predominantly focused on OECD countries, this paper mainly revolves around the consequences of the oil supply shocks of the given countries in a wider spectrum, including more than 30 countries covering 90% of world's GDP. Adopting this approach, therefore, not only leads to identifying trade relations in the global setting but also provides a deeper understanding of financial linkages through various transmission channels, such as, equity prices and exchange rates.

This study has been organized as follows: the introduction section is followed by the research literature. The next step presents a model for global oil markets by integrating them with a compact quarterly model for the global economy. In the third section, the estimation of the GVAR-Oil Model is explained. The fourth section of the study addresses the global macroeconomic consequences of Iran-specific and Saudi Arabia-specific oil supply shocks. Ultimately, the results are proposed.

2.background and related work

2.1. Impact of oil shocks on production

Oil price rise directly leads to higher national income through higher export revenue among oil-exporting countries. A major part of this profit is covered by the loss caused by lower export demand due to business partners' economic recession(Akpan, 2009).

Increased oil price redirects income and resources from oil-importing countries to oil-exporting ones, which leads to a higher wealth effect in oil-exporting countries. Hence, households, consumers, and government obtain a higher income that, in turn, results in higher demand for products. On the other hand, the higher demand makes forms to increase production; hence, the production rate will increase in oil-exporting countries(Maravalle, 2013).

According to evidence from the 1970s, oil shock leaves a considerable impact on production or output; hence, economic entities believed in the remarkable impact of higher oil prices on the product. The economic entities revised their beliefs gradually considering the lower impact of oil prices on the product. The impact of the oil shock on the product has been reduced due to firms' beliefs and the substitution of production factors. Since expectations play a vital role in determining the oil change rate, the impact of oil price shock on the expectations can amplify macro variables' reactions.

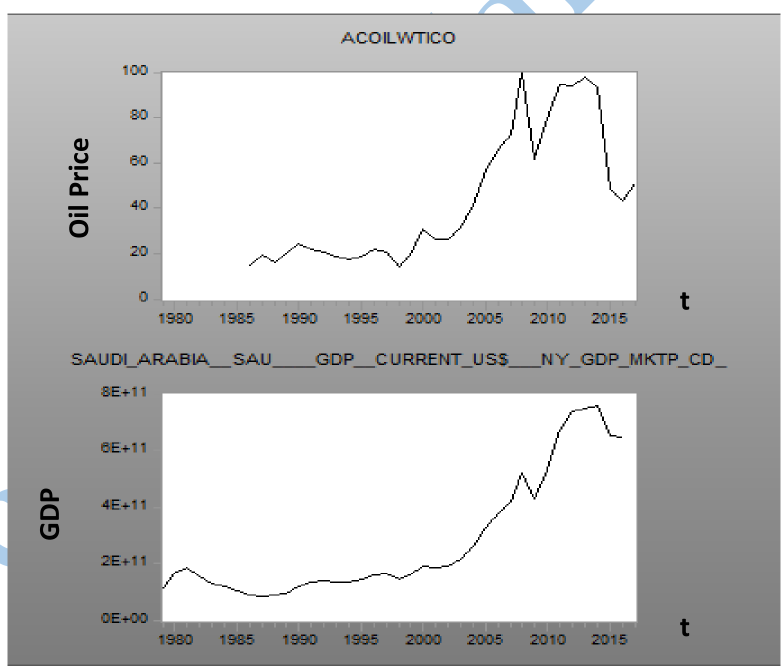


Figure 1: Saudi Arabian's GDP and Oil price

source: world bank

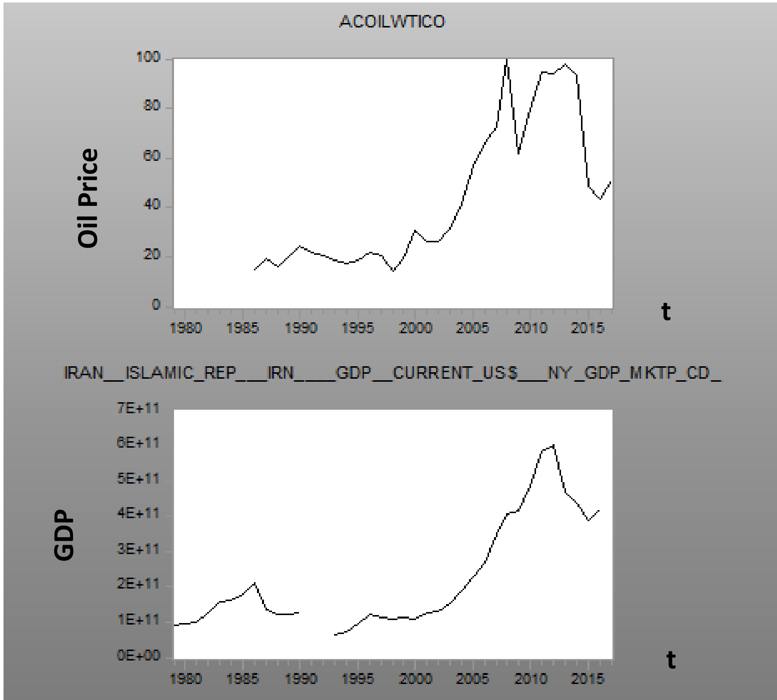


Figure 2: Iran's GDP and Oil price
source: world bank

As illustrated in figures(1),(2) there is a significant relationship between oil price shock and GDP fluctuations oil-exporter countries.

Given the high degree of dependence of Iran's economy on oil revenues, the oil sector accounts for about 15% of nominal GDP during the period 1996–2002. In addition, around 50% of government revenue and 70-75% of exports originates in the oil sector. Iran's economy is characterized by a bloated and inefficient state-owned sector, over dependence on the oil sector, and statist policies that make major twists all through. Oil income instability and "stop-go" policies has also influenced economic performance which leads to boom and bust cycles. In addition, temporary increases in crude oil price lead to increased spending, which is often sustained even after oil revenues decline again(Mehrara & Oskoui, 2007).

2.1. related studies

Kilian (2008), compares the effects of exogenous oil supply shocks on the global crude oil production in 7 large industrial economies. The author suggests that an exogenous oil supply disturbance causes an interim decline in the real GDP growth rate occurring in the second year after the shock. Despite the numerous qualitative similarities, strong statistical evidence indicates that response to exogenous oil-supply fluctuations differs among the seven studied industrial economies (Kilian, 2008).

Salehi Esfahani et al. (2014), carried out a study entitled "an empirical growth model for major oil exporters". This paper develops a long-run growth model for a major oil-exporting economy then creates conditions under which oil revenues likely have a lasting impact. The long-run theory was designed using quarterly data of nine major oil economies, six member states of OPEC (Iran, Kuwait, Libya, Nigeria, Saudi Arabia, and Venezuela), plus Indonesia which is a former member, and Mexico and Norway that are members of the OPEC. In general, the test results support the long-run theories. This study addressed the long-run relationships between real output, foreign output, and real oil income existing between six out of nine abovementioned economies. As exceptions, Mexico and Norway do not possess sufficient oil reserves for oil income to have lasting impacts on their economies. At their current production rates, the proven oil reserves of Mexico and Norway are expected to last 9 and 10 years, respectively, as compared to reserve ratios of OPEC members, which lie in the range of 45-125 years. In the case of Indonesia, the share of oil income in GDP has been declining over the past three decades (Salehi Esfahani, Mohaddes, & Pesaran, 2014).

A wide range of methods has been used to simulate and analyze data in different settings (Baumeister & Peersman, 2013a, 2013b; P. Cashin, Mohaddes, Raissi, & Raissi, 2014; Chudik & Fidora, 2012; Hansen, 1992b; Kilian, 2009; Kilian & Murphy, 2012, 2014; Peersman & Van Robays, 2012; Pesaran, Shin, & Smith, 2000; Ploberger & Krämer, 1992; Quandt, 1960).

Jarretta et al. (2019), studied oil price volatility, financial institutions, and economic growth of 30 oil-producing countries by using the CS-ARDL approach during 1980-2016. Findings indicated that better financial institutions could improve macroeconomic stability and reduce the dependence of quantitative adjusting mechanisms in oil-exporting countries. Moreover, better financial institutions could decline oil prices. In general, the flexible and free fiscal system led to a rapid adjustment of the market in case of oil price volatilities regarding the better capital allocation and sustained growth (Jarrett, Mohaddes, & Mohtadi, 2019).

Nonetheless, a different methodology was required to address small-scale country-specific oil supply shocks. To this end, originally suggested by Pesaran et al. (2004), the Global Vector Autoregressive (GVAR) approach paved the way for modelling interactions in a complex high-dimensional system by which capturing transmissions in a wide variety of channels has been

facilitated. For instance, Baumeister and Peersman (2013b), studied the Time-Varying effects of oil supply shocks on the US economy. Their findings explain why an oil production shortfall of the same magnitude is associated with a stronger response of oil prices and more severe macroeconomic consequences over time, while a similar oil price increase is associated with lower oil production and loss rate in the US production over the recent years. This study also shows that oil supply shocks account for a smaller fraction of real oil price variability indicating the more vital role of oil demand shocks. Despite the variability of this time, the overall aggregate effect of oil supply disruption on the US economy has been modest (Baumeister & Peersman, 2013b).

Azomahou et al.(2021) investigated the results caused by oil price shocks with open-economy DSGE model that uses demand for and supply of oil while making it possible for interaction between domestic and foreign monetary policy. Quantifying the relative value of oil price shock and monetary policy response on big-scale variables was made possible with availability of Canadian and U.S data. They concluded that over 40% of discounted variation in domestic output in a four-year horizon subsequent to an oil shock is due to domestic monetary policy. On the contrary, in the case of US monetary policy, the international channel was shown to be less prominent when price shocks on an oil-exporting economy are concerned(Azomahou, 2021).

Delpachitra et al studied the consequences of two simultaneous shocks in Africa; one from the COVID-19 outbreak and that of oil price shocks. They came to the conclusion that countries relying mainly on oil experienced a loss of -7.6% points GDP growth while deaths related to COVID-19 accounted for -2.75% points forecasted GDP growth loss. They argued that the damages to the African economy caused by two shocks could be as significant as – 10.75% points. To address this problem, they proposed five key policies which could potentially be helpful. These policies range from environmentally-friendly ones to diversifying the economy and novelties in technology as well as financial and social safety plans(Delpachitra, 2020).

2. Research methods

The Global Vector Autoregressive (GVAR) approach which was originally put forward by Pesaran et al (2004), offers an efficient model of interactions in a complex high-dimensional system such as the universal economy. Although GVAR is not the first global macroeconomic model of the world economy, methodologically it deals with dimensionality (i.e. the more the dimension of the model grows, the more parameters would be) in a theoretically coherent and statistically consistent manner. (Chudik & Pesaran, 2016). The GVAR approach can be summarized as a two-step method. First, small-scale country specific models are calculated based on other estimates in the world. These models are named VARX* including domestic variables and the mean values of the weighted values of foreign variables commonly referred to as "star variables". In the second stage, the country-individual models of the VARX* are stacked and simultaneously solved as a large global VAR model which can be used to analyze and predict the shock scenario (Chudik & Pesaran, 2016).

2.1. GVAR-Oil model

This combination model, which connects the world economy and oil prices in two ways, is known as GVAR-Oil. Changes in the conditions of the world economy and oil supplies which change oil prices with a break through the potential impact on all GVAR-Oil-specific variables of countries. Similarly, for the major oil producers in the specified country model, changes in oil supply are affected by oil prices in an oil price cycle as defined in the oil price equation.
The following equation is obtained from the combination of the above oil price equation with country-specific models:

$$\begin{pmatrix} 1 & w'_{ep} \\ -\Upsilon_0 & I_k - H0 \end{pmatrix} \begin{pmatrix} p_t^o \\ x_t \end{pmatrix} = \begin{pmatrix} c_p \\ \varphi_t \end{pmatrix} + \begin{pmatrix} \phi_1 & \phi_1 w'_{ep} + \alpha_1 w'_y + \beta_1 w'_q \\ \Upsilon_1 & \Phi + H_1 \end{pmatrix} \begin{pmatrix} p_{t-1}^o \\ x_{t-1} \end{pmatrix} + \begin{pmatrix} u_t^o \\ \mathbf{u}_t \end{pmatrix} \qquad (1)$$

vectors and the elements are zero or equal to weights wi or wi0, assigned to epit,yit or q0it. This can be seen in (1) .

Which is written quite concisely below:

$$\mathbf{G}_0 \mathbf{z}_t = \mathbf{b}_t + \mathbf{G}_1 \mathbf{z}_{t-1} + \mathbf{v}_t \qquad (2)$$

Based on the assumption that I_k - H_0 is invertible, the GVAR-Oil model has the solution as the following reduced form

$$\mathbf{z}_t = \mathbf{a}_t + \mathbf{F}\mathbf{z}_{t-1} + \zeta_t \qquad (3)$$

Where

$a_t = \mathbf{G}_0^{-1} b_t$, $\mathbf{F} = \mathbf{G}_0^{-1}\mathbf{G}_1$, $\xi_t = \mathbf{G}_0^{-1}\mathbf{v}_t$ (Arthur, 1998; Dees, Mauro, Pesaran, & Smith, 2007; Hashem, Til, & Scott; Mohaddes & Pesaran, 2016).

2.2. Data references

The main data reference used to estimate the GVAR-OIL model is (Mohaddes & Raissi, 2020). Which covers seasonal observations for most variables from 1979Q2-2016Q4. We strengthened this database with seasonal observations for Iran and oil production. Consumer price index and GDP data, the exchange rate for Iran in the period 1979Q1-2006Q4 has been extracted from (Esfahani, Mohaddes, & Pesaran, 2014). These series have been used using online data of the Central Bank (CBI) as well as several volumes of economic reports of the Central Bank and the World Bank monthly consumer price index. Iran's GDP data using the International Monetary Fund (IMF) and World Bank data updated. Exchange rate data from the International Monetary Fund (for free-market exchange rates) and finally, the seasonal oil price time-series data (on the scale of one thousand barrels per day) was extracted from the US Energy Information Administration.

2.3. Trade weights

The w_{ij} trading weights for calculating external variables are based on data extracted from the International Monetary Fund and are presented in the 27*27 matrix. According to the years 2007-2009, the most important trading partner for Iran is the Eurozone, Which is 25% of Iran's total trade. Trade with China-India-Korea has increased (19% -9% -12%), respectively over the past two decades. In fact, more than 57% of Iran's trade is with Asian countries. However, this number is likely to increase significantly following the US sanctions in 2011 and the EU oil sanctions and financial sanctions against Iran in 2012. Other countries in our sample that Iran's total trade with them is more than 5%, include Japan (14%), and Turkey (7%), numbers in parentheses are trade shares. Comparing Iran with Saudi Arabia, It can be concluded that although Saudi Arabia's trade share with China (12%), the Eurozone (16%), Japan (16%) and Korea (10%) are significant, Saudi trade, in general, has been less focused on Asia and Europe. For example, the United States (19%) in Saudi Arabia's most important trading partner.

3. Empirical application

The model includes 34 economies, which together cover more than 90% of the world Gross Domestic Product (GDP). Of these, 10 countries are classified as major oil producers; Based on the average for the years 2004-2013, they produce more than one percent of the world's total oil supply (Table 1). Major oil exporters such as Canada, Iran, Mexico, Norway, and Saudi Arabia meet this condition. The same is true of Britain, which was a sheer exporter of oil until 2006, and Indonesia, which was a member of OPEC until January 2009. In addition, there are three countries in our sample, Brazil, China, and the United States, which produce significantly more than 2.4 million barrels per day. However, as net importers of oil, these countries are 11th, 4th, and 2nd, the biggest producers in the world respectively.

Unfortunately, we are not able to include Iraq in our sample (despite having the fifth-largest proven oil reserves in the world) due to the lack of sufficient long-term time series data for this country. In addition, for Russia, the third-largest oil producer in the world, seasonal observations are not available for the sample period.

Table 1: Countries and Regions in the GVAR Model

Major Oil Producers	Other Countries	
Net Exporters	**Europe**	**Asia pacific**
Canada	Austria	Australia
Iran	Belgium	India
Indonesia	Finland	Japan
Mexico	France	Korea
Norway	Germany	Malaysia
Saudi Arabia	Italy	New Zealand
	Netherlands	Philippines
Net Importers	Spain	Singapore
Brazil	Sweden	Thailand
China	Switzerland	
United Kingdom		
United states	**Rest of the Word**	**Latin America**
	South Africa	Argentina
	Turkey	Chile
		Peru

An important common feature of the 10 major oil producers is that their daily oil production plays an important role in the world oil market. However, the amount of oil production, exports and the level of stabilized oil reserves, and the excess oil capacity of these countries are significantly different from each other (Table 2).

In particular, Table 2 shows that despite the fact that Iran has significant oil reserves (in the 4th largest oil country in the world), Iran's oil production is less than 5% of world oil production. This is similar to Chinese production, which has only about 1% of the world's known reserves. What may come as a surprise is that Canada, in fact, has larger oil reserves than Iran, but exports about 1 million barrels per day less than Iran.

Table 2 also shows that Saudi Arabia plays a key role in the world oil supply. Not only more than 12.9% of world oil production but also 17% of stabilized oil reserves and about 16.7% of world oil exports, which is almost similar to the sum of the four major oil exporters in the sample. In addition, Saudi Arabia is not only the largest world's oil producer and exporter but has the largest excess capacity and is seen as a producer of fluctuating regulators. Therefore, it is expected that world oil supply disruptions will be remedied by increasing Saudi Arabia's oil production. Saudi Arabia's oil supply disruptions, on the other hand, can potentially only be partially offset by other producers, most of whom have production capacity close to or similar to Saudi production.

Table 2: Oil Reserves, Production and Exports of Major Oil Producers, averages over 2004-2019 †

	Oil Production		*Oil Exports*		*OIL Reserves*	
Country	Million percent Barrels/day	percent of world	Million percent Barrels/day	percent of world	Billion Barrels	percent of world
Net Exporters						
Canada	3.9	4.4	2.02	4.8	174.5	10.9

Indonesia	.96	1.1	.3	.7	3.7	.23
Iran	4	4.5	1.97	4.6	148.9	9.3
Mexico	2.9	3.3	1.5	3.5	10.4	.65
Norway	2.2	2.5	1.6	3.8	7.9	.49
Saudi Arabia	11.4	12.9	7.1	16.7	271.1	17
Net Importers						
Brazil	2.7	3	.62	1.5	13.4	.84
China	4.3	4.8	.07	.2	23.2	1.45
United Kingdom	1.3	1.4	.77	1.8	3	.19
United States	10.95	12.3	.5	1.2	43.6	2.73
World	88.9	100	42.5	100	1595.3	100

† Source: Oil production data are from the U.S. Energy Information Administration *International Energy Statistics*, oil reserve data are from the British Petroleum *Statistical Review of World Energy* and oil export data are from the OPEC *Annual Statistical Bulletin*.

$$ep_t = \sum_{i=}^{N} w_i ep_{it}. \qquad (4)$$

$$y_{t=} \sum_{i=1}^{N} w_i y_{it,}\; q_t^o = \sum_{i=1}^{N} w_i^o\, q_{it}^o. \qquad (5)$$

We calculated the ep_t and y_t obtained from Equations (4) and (5) based on PPP-GDP weights.

Specifically $ep_t = \sum_{i=1}^{N} \ln\left(\frac{Eit}{CPIit}\right)$〗 and $y_t = \sum_{i=1}^{N} wiln(GDPit)$

that Eit is the US dollar exchange rate, $CPIit$ is consumer price index and $GDPit$ is real GDP of the ith country in the time t,i = 1,2,…, N and Wi, weight of the ith country PPP-GDP with respect to $\sum_{i=1}^{N} Wi=1$

To reduce the effect of individual changes on weights, we calculated Wi based on a three-year average of 2007-2009 .To supply world oil, we used the relation $q_t^o = \sum_{i=1}^{N} wi^o \; qit^o$

Which qit^o = 0 for the euro area and 16 countries where producers are not major oil (Table 1 shows the list of major oil producers).

We considered oil exports and production in deciding about Wi^o, but the results of satisfactory oil exports and production were not obtained. For example, according to weight-based on oil export values $w_{us}^o = 0$.

Despite the fact that US production is about 11% of world production, On the other hand, finding on the basis of oil production does not indicate the importance of final changes in oil exports at oil prices.

Given the vast nature of the international oil trade, we decided to adopt an equal weight scenario, which puts equal weight on the relative changes in oil production among all major oil producers. Finally $p_{t=\ln\,(p_t^o)}^o$ which p_t^o is the price of Brent crude oil is calculated in US dollars (Salehi Esfahani et al., 2014; Smith & Galesi, 2014).

3.1. Estimation of country-specific VARX* model

Our analysis covers 34 countries. In the GVAR-OIL model structure, there is a block of 8 countries (Austria, Belgium, Finland, France, Germany, Italy, the Netherlands, and Spain) of the 11 countries that first joined the Eurozone in January 1999. Time series data was made in the form of cross-sectionally weighted by the weighted average of the variables of the 8 countries of the euro area and based on the Purchasing Power Parity GDP (PPP GDP) weights in the average time period 2009-2007.

Shown in Table 1, the seasonal GVAR-oil model is for the period 1979Q2-2019Q4; See Appendix A to create variables. We also briefly provide evidence of the weak exogenous hypotheses of external variables and discuss the structural failure of the GVAR-oil model in Appendix B (M. P. Cashin, Mohaddes, & Raissi, 2015; Dees et al., 2007; Rey, 2015).

3.1.1. Unit root tests

To interpret long-term relationships, as well as to ensure that we do not work with a combination of variables I (2), I (1), we need to consider the unit root properties of the variables in country-specific models. We used the Augmented Dickey-Fuller (ADF) unit tests as well as the generalized Dickey-Fuller weight symmetric tests (ADF-WS) provided by (Park & Fuller, 1995). ADF-WS tests are more powerful than standard generalized Dickey-Fuller tests in some applications. For brevity, results are not reported here but are available on request.

3.1.2. Testing the weak exogeneity assumption

A weak exogenous test of external and global variables was performed, the results of which are shown in Table A.1 (Harbo, Johansen, Nielsen, & Rahbek, 1998; Johansen, 1992).

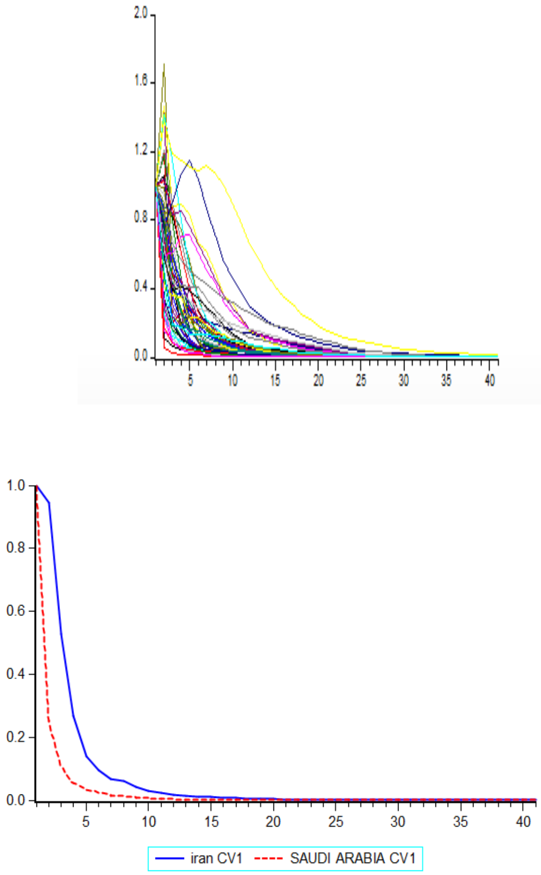
3.1.3. Tests of structural breaks

The possibility of structural breaks is a major problem in macroeconomic modeling. Table A.2 presents the number of rejected null hypotheses for parameter stability for each variable among country-specific models at a significance level of 5%. For brevity, test statistics, and critical Bootstrap values are not reported here, but these results are available. In general, most regression coefficients appear to be stable. However, the results vary from test to test. In the case of the two pk tests, the null hypothesis of 10% -11% of the cases are rejected at the moment. For the NY, MW, QLR, APW tests, (Andrews & Ploberger, 1994; Dees et al., 2007; Nyblom, 1989; Quandt, 1960) on the other hand, the much higher rate is rejected between 14% -49% of the cases. For QLR and APW assumptions of zero coefficient stability and error variance stability, 78 and 79 out of 162 are rejected. However, following the robust version of these tests, we reduce the rejection rate to 12% and 20%. Therefore, we saw evidence of structural instability, which seems to be the main reason for possible changes in error variance greater than the parameter coefficients (Table A.3).

3.2. Lag order selection, cointegrating relations, and persistence profiles

The GVAR model must be globally stable, meaning that long-term convergence relationships must be reversible to their average. In the initial PPS analysis for the GVAR-oil model, we found that in some countries the convergence rate is almost low. Especially the adjustment speed is very low for Norway, South Africa, and the UK. As you can see in Table B.1, the graphs for 5 of the 57 stacked vectors jumped before reaching zero. For Iran and Saudi Arabia, we designed PPS in the shape of b1, c1. For these two major oil exporters, we concluded that the convergence rate was very high, which was in line with the other reported exporters (MacKinnon, 1991; Pesaran et al., 2000).

(a) All Countries



(b) Iran, Saudi Arabia

Figure 3: Persistence Profiles of the Effect of a System-wide Shock to the Cointegrating Relations

4- Counterfactual analysis of oil supply shocks

4.1. Reducing oil supply shock by Iran

Dealing with country-specific shocks is a new issue that has not been considered in the analysis of world oil supply and demand. We first consider the effects of the negative shock of Iran's oil supply on production and oil prices. Figure 4 clearly shows that following the supply shock, Iran's production temporarily decreases by about 4.9% in the first four quarters. In response to the decline in Iranian oil production and to stabilize oil markets, other OPEC producers (especially Indonesia and Saudi Arabia) increased their production, Saudi Arabia's production first increased by 1.04% and finally in the long run increased by 2.14%. As a result, oil prices increased unchanged in the short run and 0.15% in the long run.

Oil production in Iran and Saudi Arabia in the period 1980-2019 is shown in Figure 5, and we will clearly see two separate periods of great decline in Iran oil production. One period coincides with the Iranian Revolution and the aftermath was known as the 1978 period. The second term began in mid-2011, coinciding with the increase in sanctions against Iran. In the first period, however, the revolution, the upheavals, and the strike of the oil workers stopped the production of

Iran oil in 1971-1978. But the deliberate decision of the Provisional Government of Iran was to reduce the level of oil production to about 30% below the average level of the period 1978-1971 (Mohaddes & Pesaran, 2013). However, it turned out that the Iraqi invasion of Iran in 1980 significantly reduced oil production, and refining capacity and the actual production fell from about 6 million barrels per day in 1978 to an average of 2.1 million barrels per day in 1980. What is interesting is that, as shown in Figure 3, the decrease in Iranian supply was initially partially offset by an increase of 1.6 million barrels per day by Saudi production from 1978-1981. The second major supply shock for Iran is related to some of the sanctions imposed on Iran by the United States in 2011 and followed by the European Union in 2012, which include:

1- Punishment of companies including upstream activities of Iran and petrochemical industry
2- Sanctions of the Central Bank of Iran
3- Ending financial services (to financial transactions) to Iranian banks

Finally, the full embargo on Iran's oil imports, as a result of these extensive oil and financial sanctions, reduced Iran's oil production and exports. According to the US Energy Agency, between January 2011 and June 2014, oil production fell by 875,000 barrels per day.
What is interesting is that during this period, Saudi Arabia's production increased by 865,000 barrels per day. When Iran's oil production was greatly reduced due to various political factors. Compensation for this reduction is possible only by Saudi Arabia, which is in a position to produce global volatility, but note that outside of these two periods (1978-1979 and 2011 onwards) Saudi oil production is very unstable, but Iran's oil production is relatively Remained stable (Hansen, 1992a).

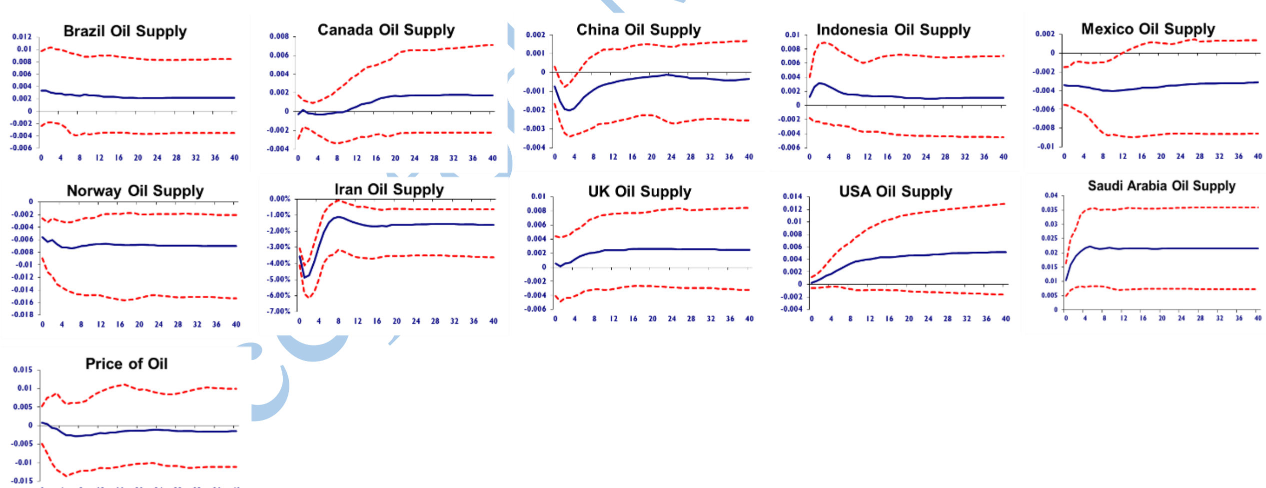


Figure 4: Structural Impulse Responses of a Negative Unit Shock to Iranian Oil Supply

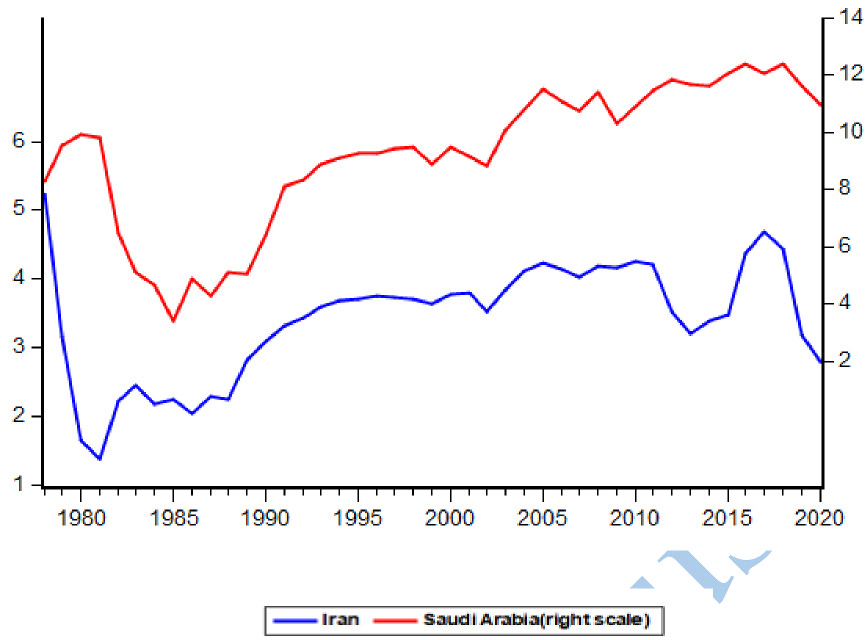


Figure 5 Iranian and Saudi Arabian Oil Production in Million Barrels per Day, 1980-2020

The effects of Iran's oil supply shock on GDP indicate that real production fell by .37% in the short run and 1.59 % in the long run (Figure 6). In Saudi Arabia, however, the drop in oil prices was offset by increased oil production. As a result, real production increased by 0.43% in the long run and by 0.06% in the short run. In general, it can be supposed that the shock effects of Iran's oil supply on the world economy have been neutralized by compensating for the increase in Saudi Arabia's oil production.

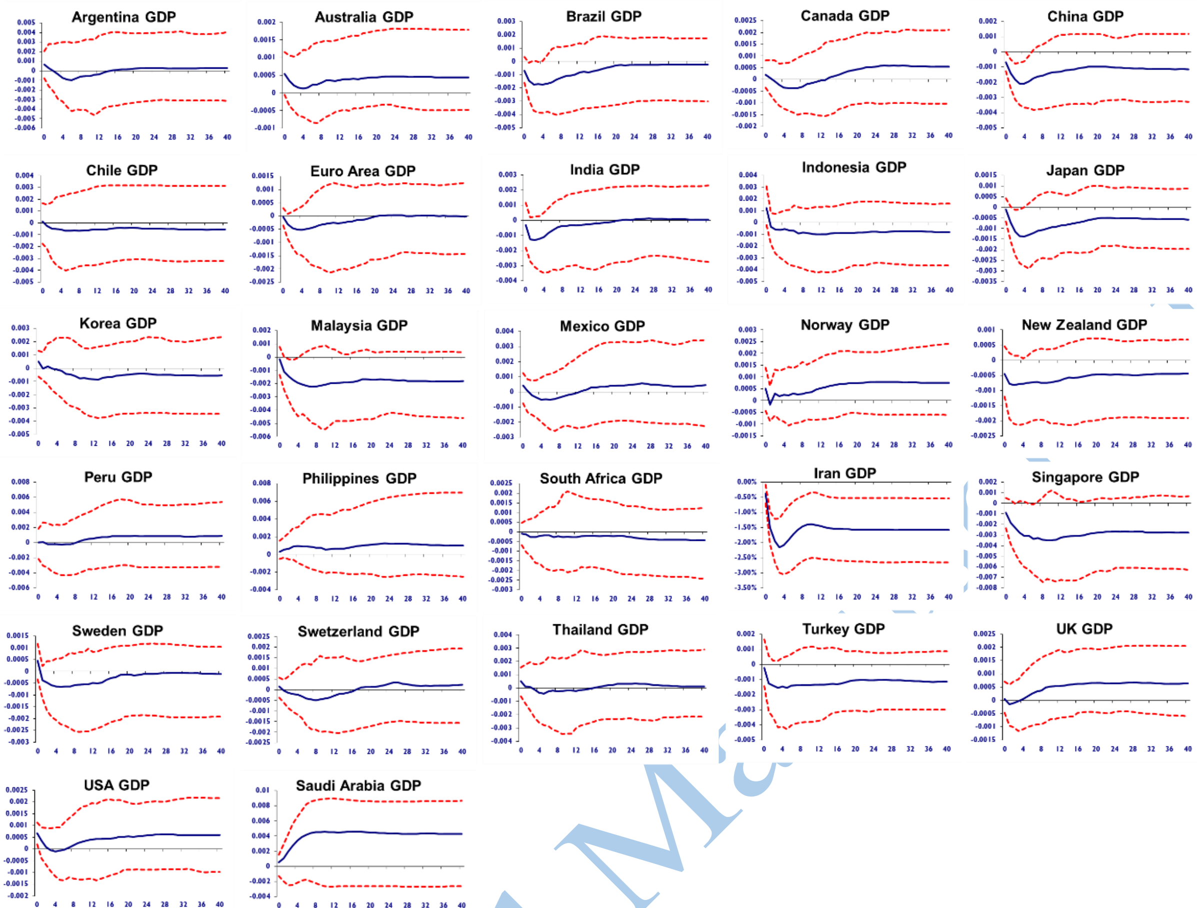


Figure 6: Structural Impulse Responses of a Negative Unit Shock to Iranian Oil Supply

4.2. Reduction of oil supply shock by Saudi Arabia

Figure 7 shows the negative effects of Saudi Arabia's supply shock on oil prices as well as the world oil supply. It can be seen that Saudi Arabia's production decreased by 9.9% per season in the long run. But in the short term, Norwegian and Iranian oil production has increased by 3% and 1% per quarter, respectively. But given that all major producers except Saudi Arabia produce at or near capacity, the reduction in Saudi Arabia's supply will not be offset by other producers in the long run. As a result, oil prices increase by 0.38%. Larger effects have been documented following Saudi Arabia's decision to make major changes to its production. In September 1985, for example, Saudi Arabia's production rose from 2 million barrels per day to 4.7 million barrels per day, dropping from 59.67 to 30.67 dollars.

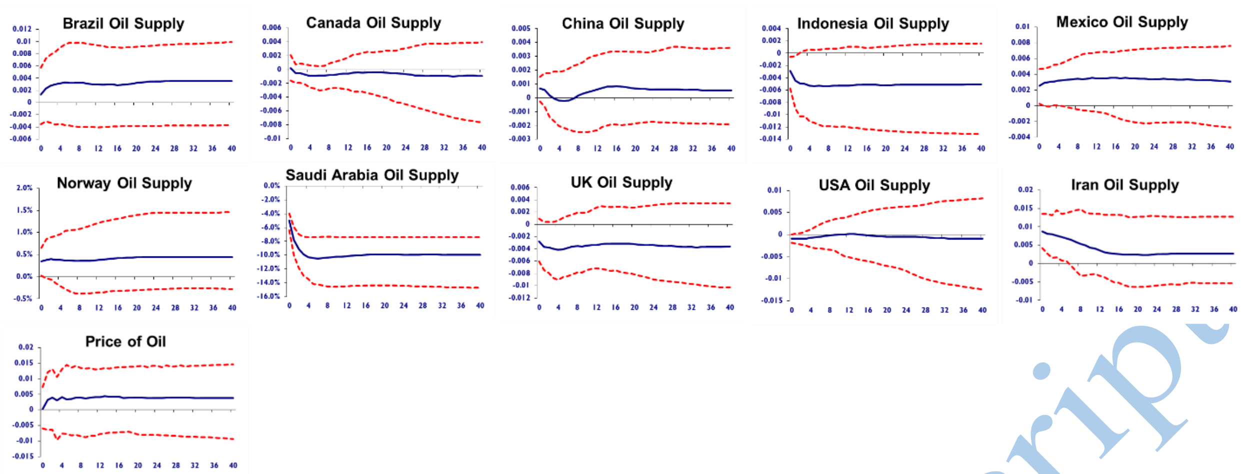


Figure 7: Structural Impulse Responses of a Negative Unit Shock to Saudi Arabian Oil Supply

The effects of the negative shock of Saudi oil production on the actual production of 26 countries and the Eurozone are shown in Figure 8. Saudi Arabia's real production will decrease by 2.21% in the long run. On the other hand, Iran's real GDP in the short run will increase by 0.07% and in the long run by 0.2%. Looking at the importers of crude oil from Figure 6, we find that almost all the effects are moderately negative, and for the following countries, such as Argentina (-.4%), Australia (- 0.09%), Chile (-0.1%) , Korea (-0.39%) , Malaysia (0.09%), United Kingdom (-0.01%), USA (-0.0005%), moderate effects are reported in the sixteenth season.

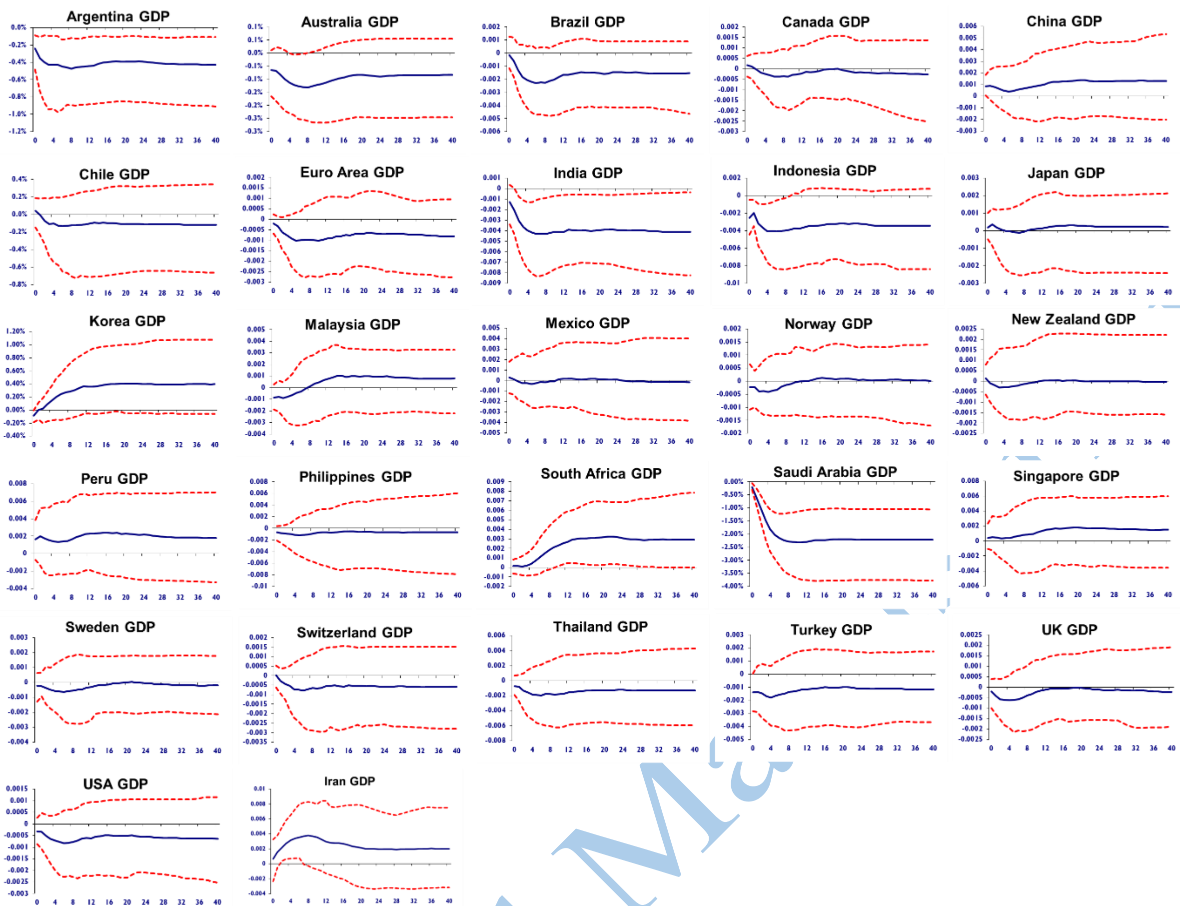


Figure 8: Structural Impulse Responses of a Negative Unit Shock to Saudi Arabian Oil Supply

4.3. Forecast Error Variance Decomposition

As can be seen in figure (9), the results of variance decomposition of Gross Domestic Product show that fluctuations in GDP are caused by many factors. The first factor is lag of GDP and the second is oil supply shock. It is worth mentioning that the latter gradually gains momentum. (figures related to Forecast Error Variance Decomposition is available in appendix B.5)

In the first year, the oil supply shock explains about 2% of Iran's GDP fluctuations which increases to more than 20% in the next two years. In Saudi Arabia, the oil supply shock accounts for about 5% of GDP fluctuations in the short run. In the long run, the oil supply shock is the main cause of GDP fluctuations in Iran and Saudi Arabia. In the long run, the GDP fluctuations in Iran and Saudi Arabia are 23% and 25% respectively. The high vulnerability of Iran and Saudi Arabia to oil supply changes is due to the high degree of their dependence on oil revenues.

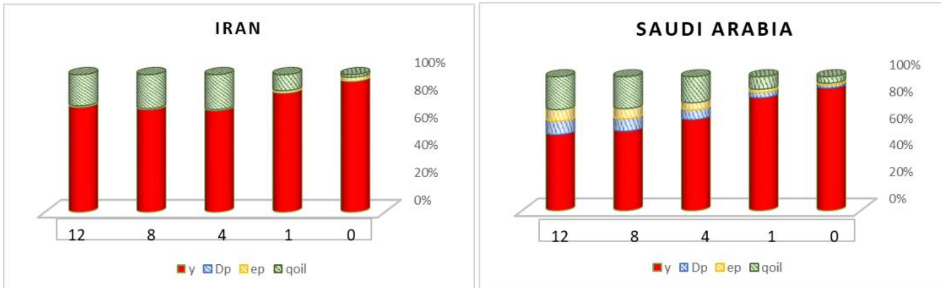


Figure 9: GDP Variance Decomposition

5. Conclusion and Policy Implications

This study proposed a quarterly model for oil markets that covers both global supply and demand conditions; the combined model is called GVAR-Oil. This paper develops the relevant literature using oil price modeling to propose a new approach to country-specific oil supply shocks in the framework of multiple countries. Quarterly observations over the period 1979Q2-2019Q4 for 27 countries were used to estimate this combined model. The key assumptions of weak exogeneity of global and country-specific foreign variables, and parameter stability were also taken into account to test this model. Based on the obtained statistical evidence, only 11 out of the 158 tests of weak exogeneity were statistically significant at the 5% level. In addition, the stability of most regression coefficients was proved in spite of instability in error variances that is consistent with the evidence on "great moderation" in the U.S. Therefore, to address the error variances instability, bootstrapping techniques were used to calculate confidence bounds for the impulse responses. The proposed model differs from the literature existing on global shock analysis. Accordingly, this study could answer some crucial questions about the macroeconomic consequences of oil supply disturbance (caused by sanctions, war, and natural disasters) for the global economy based on the country-specific approach. The result indicates that the global economic implications of oil-supply shocks are significantly different, which depends on the case that the shock is imposed from which one of the countries. In particular, findings show that a negative oil supply shock by Iran led to an increase in oil production in Saudi Arabia. Such an increase covers the declining OPEC export and keeps the oil market equilibrium.

Findings indicate that a negative shock to Iran's oil supply leads to an interim decline of 4.7% in the first four quarters. Responding to reduced oil production in Iran, the other OPEC oil producers, especially Indonesia and Saudi Arabia, have increased to an increase in production to stabilize the oil market. Accordingly, there was a 1.16% increase in oil production in Saudi Arabia, which reached 2.28% within the long-term period.

The effects of Iran-specific oil supply shock on GDP indicate 0.14% and 0.91% reduction in short-term and long-term periods, respectively. Such decline occurred due to lower short-run production and reduced long-run oil price that, in turn, led to a decline in Iran's oil revenue. It should be mentioned that the oil export revenue to real production and total export ratios are about 22% and 70% respectively, which have been maintained for more than three decades. In Saudi Arabia, however, the reduction in oil prices was covered by rising oil production. Therefore, the real production experienced an increase over long-term (0.83%) and short-term (0.08%) periods. Interestingly, many countries have had a positive med rate of production effects indicating the contribution of reduced oil prices to a rise in real production. Although this is a statistically significant response, it can be stated that the consequences of Iran's oil supply shock on the global economy have been covered by the increased oil production in Saudi Arabia. As mentioned above, the oil capacity has not been in favour of Iran. Oil production in Saudi Arabia has experienced a 9% long-run decline over each quarterly period in response to the negative oil supply shock. Nevertheless, there has been a 0.4% and 1% reduction in quarterly short-run oil production in Norway and Iran, respectively. Since all of the large producers expect Saudi Arabia to produce as much as its capacity, a decline in Saudi Arabia's supply will not be offset by other producers over a long-term period. Hence, oil prices will increase by about 0.7%. Based on the equity pricing model of Huang et al. (1996), the equity price is the same as the expected present discounted value of future cash flows. A decrease in oil price has a positive effect on stock market returns as a lower expected inflation can reduce the discount rate. Also, a number of other researchers including Cheung and Ng (1998), Sadorsky (1999), and Park and Ratti (2008) have supported the positive effect of falling oil prices on stock markets in net oil importers. Although buffers and accessible financing help most oil exporters to prevent sharp cuts in government spending in the near term, the long-term effect relies on their medium-term financial plans and capital spending. (Mohaddes & Raissi, 2019)

References

Akpan, E. O. (2009). *Oil price shocks and Nigeria's macro economy.* Paper presented at the A Paper Presented at the Annual Conference of CSAE Conference, Economic Development in Africa, March.

Andrews, D. W., & Ploberger, W. (1994). Optimal tests when a nuisance parameter is present only under the alternative. *Econometrica: Journal of the Econometric Society*, 1383-1414.

Arthur, W. (1998). Amundsen, ES and R. Schob.(1999).“Environmental taxes on exhaustible resources.” European Journal of Political Economy, 15, 311–29. Antweiler, W. and D. Trefler.(2002).“Increasing returns and all that: a view from trade.” The American Economic Review, 92 (1), 93–119. Arkolakis, C., A. Costinot, and A. Rodriguez-Clare.(2012).“New trade. *Journal of Environmental Economics and Management, 23*, 289-300.

Azomahou, e. a. (2021). Coping with a dual shock: The economic effects of COVID-19 and oil price crises on African economies. *Resources Policy, 72*, 102093.

Baumeister, C., & Peersman, G. (2013a). The role of time-varying price elasticities in accounting for volatility changes in the crude oil market. *Journal of applied Econometrics, 28*(7), 1087-1109.

Baumeister, C., & Peersman, G. (2013b). Time-varying effects of oil supply shocks on the US economy. *American Economic Journal: Macroeconomics, 5*(4), 1-28.

Cashin, M. P., Mohaddes, M. K., & Raissi, M. M. (2015). *Fair weather or foul? The macroeconomic effects of El Niño*: International Monetary Fund.

Cashin, P., Mohaddes, K., Raissi, M., & Raissi, M. (2014). The differential effects of oil demand and supply shocks on the global economy. *Energy Economics, 44*, 113-134.

Chudik, A., & Fidora, M. (2012). How the global perspective can help us identify structural shocks. *Staff Papers*(Dec).

Chudik, A., & Pesaran, M. H. (2016). Theory and practice of GVAR modelling. *Journal of Economic Surveys, 30*(1), 165-197.

Dees, S., Mauro, F. d., Pesaran, M. H., & Smith, L. V. (2007). Exploring the international linkages of the euro area: a global VAR analysis. *Journal of applied Econometrics, 22*(1), 1-38.

Delpachitra, e. a. (2020). The impact of oil price shocks in the Canadian economy: A structural investigation on an oil-exporting economy. *Energy Economics, 91*, 104846.

Esfahani, H. S., Mohaddes, K., & Pesaran, M. H. (2014). An empirical growth model for major oil exporters. *Journal of applied Econometrics, 29*(1), 1-21.

Gately, D., & Huntington, H. G. (2002). The asymmetric effects of changes in price and income on energy and oil demand. *The Energy Journal, 23*(1).

Hamilton, J. D. (2009). *Causes and Consequences of the Oil Shock of 2007-08*. Retrieved from

Hansen, B. E. (1992a). Efficient estimation and testing of cointegrating vectors in the presence of deterministic trends. *Journal of Econometrics, 53*(1-3), 87-121.

Hansen, B. E. (1992b). The likelihood ratio test under nonstandard conditions: testing the Markov switching model of GNP. *Journal of applied Econometrics, 7*(S1), S61-S82.

Harbo, I., Johansen, S., Nielsen, B., & Rahbek, A. (1998). Asymptotic inference on cointegrating rank in partial systems. *Journal of Business & Economic Statistics, 16*(4), 388-399.

Hashem, P. M., Til, S., & Scott, W. *Modelling Regional Interdependencies using a Global Error-Correcting Macroeconometric Model*. Retrieved from

Jarrett, U., Mohaddes, K., & Mohtadi, H. (2019). Oil price volatility, financial institutions and economic growth. *Energy policy, 126*, 131-144.

Johansen, S. (1992). Cointegration in partial systems and the efficiency of single-equation analysis. *Journal of Econometrics, 52*(3), 389-402.

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*(3), 1053-1069.

Kilian, L., & Murphy, D. P. (2012). Why agnostic sign restrictions are not enough: understanding the dynamics of oil market VAR models. *Journal of the European Economic Association, 10*(5), 1166-1188.

Kilian, L., & Murphy, D. P. (2014). The role of inventories and speculative trading in the global market for crude oil. *Journal of applied Econometrics, 29*(3), 454-478.

MacKinnon, J. G. (1991). *Critical values for cointegration tests.* Paper presented at the Eds.), Long-Run Economic Relationship: Readings in Cointegration.

Maravalle, A. (2013). Oil Shocks and the US terms of trade: gauging the role of the trade channel. *Applied Economics Letters, 20*(2), 152-156.

Mehrara, M., & Oskoui, K. N. (2007). The sources of macroeconomic fluctuations in oil exporting countries: A comparative study. *Economic Modelling, 24*(3), 365-379.

Mohaddes, K., & Pesaran, M. H. (2013). One hundred years of oil income and the Iranian economy: a curse or a blessing?

Mohaddes, K., & Pesaran, M. H. (2016). Country-specific oil supply shocks and the global economy: A counterfactual analysis. *Energy Economics, 59*, 382-399.

Mohaddes, K., & Raissi, M. (2019). The US oil supply revolution and the global economy. *Empirical Economics, 57*(5), 1515-1546.

Mohaddes, K., & Raissi, M. (2020). Compilation, Revision and Updating of the Global VAR (GVAR) Database, 1979Q2-2019Q4.

Nyblom, J. (1989). Testing for the constancy of parameters over time. *Journal of the American statistical Association, 84*(405), 223-230.

Park, H. J., & Fuller, W. A. (1995). Alternative estimators and unit root tests for the autoregressive process. *Journal of Time Series Analysis, 16*(4), 415-429.

Peersman, G., & Van Robays, I. (2012). Cross-country differences in the effects of oil shocks. *Energy Economics, 34*(5), 1532-1547.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2000). Structural analysis of vector error correction models with exogenous I (1) variables. *Journal of Econometrics, 97*(2), 293-343.

Ploberger, W., & Krämer, W. (1992). The CUSUM test with OLS residuals. *Econometrica: Journal of the Econometric Society*, 271-285.

Quandt, R. E. (1960). Tests of the hypothesis that a linear regression system obeys two separate regimes. *Journal of the American statistical Association, 55*(290), 324-330.

Rey, H. (2015). *Dilemma not trilemma: the global financial cycle and monetary policy independence*. Retrieved from

Salehi Esfahani, H., Mohaddes, K., & Pesaran, M. H. (2014). An empirical growth model for major oil exporters. *Journal of applied Econometrics, 29*(1), 1-21.

Smith, L., & Galesi, A. (2014). GVAR Toolbox 2.0. *University of Cambridge: Judge Business School*.

Appendix A

Table A.1: F-Statistics for Testing the Weak Exogeneity of the Country-Specific Foreign Variables and Oil Prices †

Country	F test	Critical value	y*	Δp*	ep*	r*	eq*	poil
ARGENTINA	F(2,130)	3.065839	0.213871	0.688942	-	2.531817	0.244379	1.353219
AUSTRALIA	F(3,143)	2.667887	1.917279	1.113823	-	1.210415	0.111059	0.638892
BRAZIL	F(2,144)	3.058928	0.45672	2.332558	-	1.244449	0.706187	0.627052
CANADA	F(3,142)	2.668337	1.846391	2.98877	-	2.394662	0.187474	3.790001
CHINA	F(2,144)	3.058928	0.352704	0.841141	-	0.894689	0.293235	0.661925
CHILE	F(2,144)	3.058928	0.157877	0.503378	-	0.472222	1.54697	0.265899
EURO	F(1,145)	3.906392	1.060257	0.243093	-	0.882083	1.629459	0.00609
INDIA	F(2,144)	3.058928	0.902293	0.910906	-	1.890243	0.866134	0.368497
INDONESIA	F(3,143)	2.667887	0.37168	0.711756	-	1.05024	0.904944	1.171049
Iran	F(1,146)	3.905942	0.272318	1.104507		3.192534	0.295601	0.065417
JAPAN	F(2,144)	3.058928	3.072894	2.711405	-	0.08752	0.397012	0.944858
KOREA	F(3,143)	2.667887	0.487578	1.340857	-	0.449879	1.096813	0.697473
MALAYSIA	F(2,144)	3.058928	3.74241	3.383474	-	4.380355	2.22689	2.414988
MEXICO	F(2,144)	3.058928	0.725628	1.834667	-	0.504945	0.78991	0.729867
NORWAY	F(3,142)	2.668337	2.013964	0.345422	-	0.298049	0.074303	1.45122
NEW ZEALAND	F(3,143)	2.667887	2.811685	1.841276	-	0.774817	0.319988	1.446058
PERU	F(2,145)	3.058486	0.252258	0.862871	-	2.248788	0.508262	1.379173
PHILIPPINES	F(3,143)	2.667887	0.635624	0.602582	-	2.638146	0.602635	2.422031
SOUTH AFRICA	F(2,144)	3.058928	0.374698	0.12563	-	2.072856	0.533671	0.048897
SAUDI ARABIA	F(1,146)	3.905942	0.165706	0.271721	-	0.001756	2.78487	0.007741
SINGAPORE	F(1,145)	3.906392	1.772948	0.046706	-	0.785867	3.622172	2.194722
SWEDEN	F(2,144)	3.058928	1.477172	0.777531	-	0.194513	0.166414	0.539453
SWITZERLAND	F(3,143)	2.667887	2.013937	2.492761	-	0.374835	3.299463	0.934909
THAILAND	F(2,144)	3.058928	1.225879	1.016518	-	1.473998	1.489681	1.207151
TURKEY	F(1,146)	3.905942	0.394699	1.038636	-	0.000467	1.583427	0.114865
UNITED KINGDOM	F(2,143)	3.059376	3.006507	0.056086	-	1.698699	0.229317	0.24815
USA	F(2,146)	3.05805	0.744889	4.174839	3.6802	-	-	0.512636

† Notes: * denotes statistical significance at the 5% level.

Table A.2: Number of Rejections of the Null of Parameter Constancy per Variable across the Country-specific Models at the 5 percent Significance Level †

TESTS	Y	DP	EQ	EP	R	QOIL	TOTAL
pksup	5	4	2	2	3	2	18(11)
Pk msq	4	5	1	3	0	3	16(10)
NY	3	6	1	4	4	5	23(14)
Robust-NY	1	3	1	3	5	7	20(12)
QLR	15	14	11	11	18	9	78(48)
Robust-QLR	5	3	7	11	9	3	38(23)
MW	11	7	8	8	9	7	50(31)
Robust-MW	5	5	4	9	7	3	33(20)
APW	16	14	11	11	18	9	79(49)
Robust-APW	5	4	6	11	9	3	38(23)

† Notes: The test statistics *PKsup* and *PKmsq* are based on the cumulative sums of *OLS* residuals, *NY* is the Nyblom test for time-varying parameters and *QLR*, *MW* and *APW* are the sequential Wald statistics for a single break at an unknown change point. Statistics with the prefix ‘robust’ denote the heteroskedasticityrobust version of the tests. All tests are implemented at the 5% signifcance level. The number in brackets are the percentage rejection rates.

Table A.3: Break Dates Computed with Quandt's Likelihood Ratio Statistic†

Country	y	Δp	ep	r	qoil	Eq
ARGENTINA	1994Q3	1990Q3	1989Q3	1990Q2	-	1985Q4
AUSTRALIA	1991Q4	1990Q4	1986Q3	1987Q3	-	1988Q2
BRAZIL	1986Q1	1989Q3	1999Q1	1989Q3	2013Q4	
CANADA	1987Q1	1994Q3	1996Q3	1986Q2	2010Q1	2000Q4
CHINA	1994Q4	1989Q4	1994Q2	1993Q2	2012Q2	
CHILE	1986Q1	1986Q1	1988Q1	1987Q2	-	1987Q4
EURO	1987Q4	1990Q1	1998Q4	1985Q3	-	1999Q3
INDIA	1988Q1	1998Q4	1991Q4	2008Q2	-	1993Q2
INDONESIA	1985Q3	1998Q3	1998Q1	1998Q1	-	
Iran	2013Q4	2013Q1	2011Q3	-	1988Q2	-
JAPAN	1990Q1	2013Q4	2007Q1	1986Q1	-	2011Q4
KOREA	1988Q2	1985Q3	1996Q4	1998Q3	-	1996Q2
MALAYSIA	1987Q3	2008Q3	1995Q2	1998Q2	-	1998Q3
MEXICO	1986Q1	1988Q1	1995Q1	1988Q1	1986Q1	
NORWAY	2010Q1	2002Q3	2003Q3	1992Q3	1996Q3	1990Q4
NEW ZEALAND	1986Q4	1986Q4	1987Q2	1986Q2		1988Q1
PERU	1990Q4	1990Q4	1991Q2	1989Q4	-	-
PHILIPPINES	1986Q1	1991Q2	1985Q4	1986Q1	-	1986Q1
SOUTH AFRICA	1986Q1	1986Q1	1988Q2	1986Q1	-	1986Q3
SAUDI ARABIA	1990Q2	1992Q2	1986Q3	-	1986Q1	-
SINGAPORE	2000Q3	1985Q3	1992Q4	1985Q3	-	1991Q1
SWEDEN	1985Q3	1993Q2	1986Q2	1985Q3	-	1985Q3
SWITZERLAND	2007Q3	1986Q1	1986Q2	1986Q4	-	1987Q4
THAILAND	2011Q3	1985Q3	1998Q2	1994Q4	-	1999Q3
TURKEY	1994Q1	1992Q4	1985Q3	1994Q1	-	-
UNITED KINGDOM	2008Q2	1987Q2	1987Q2	1988Q4	2013Q2	1992Q4
USA	1985Q3	2002Q2	-	1985Q3	2012Q4	1999Q2

†Notes: All tests are implemented at the 5% significance level.

Complementary Documents

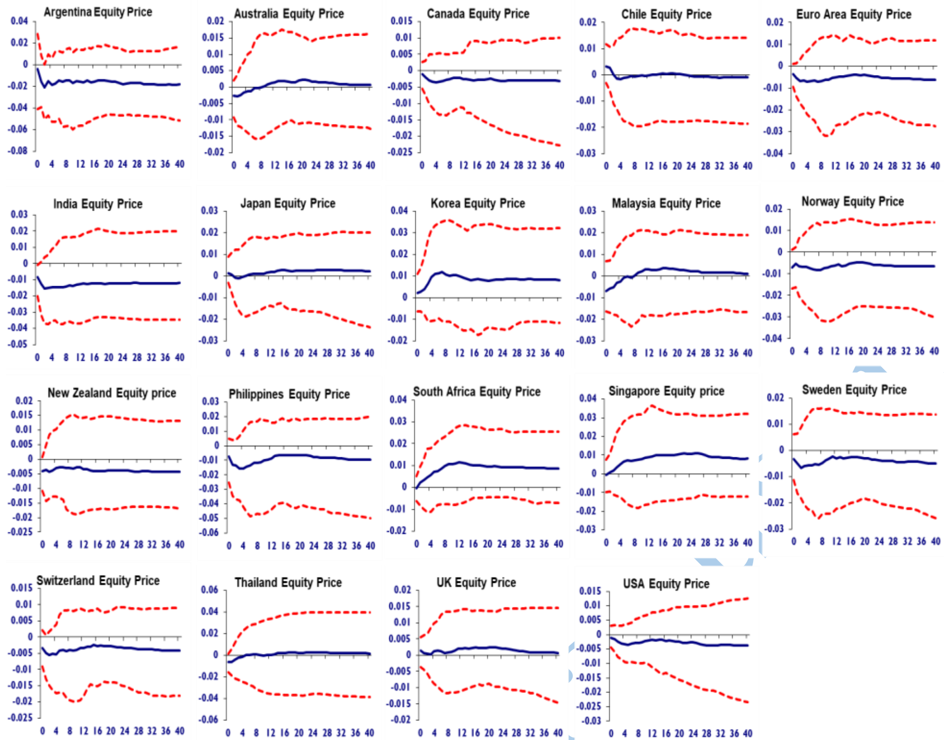


Figure B.1: Structural Impulse Responses of a Negative Unit Shock to Saudi Arabian Oil Supply

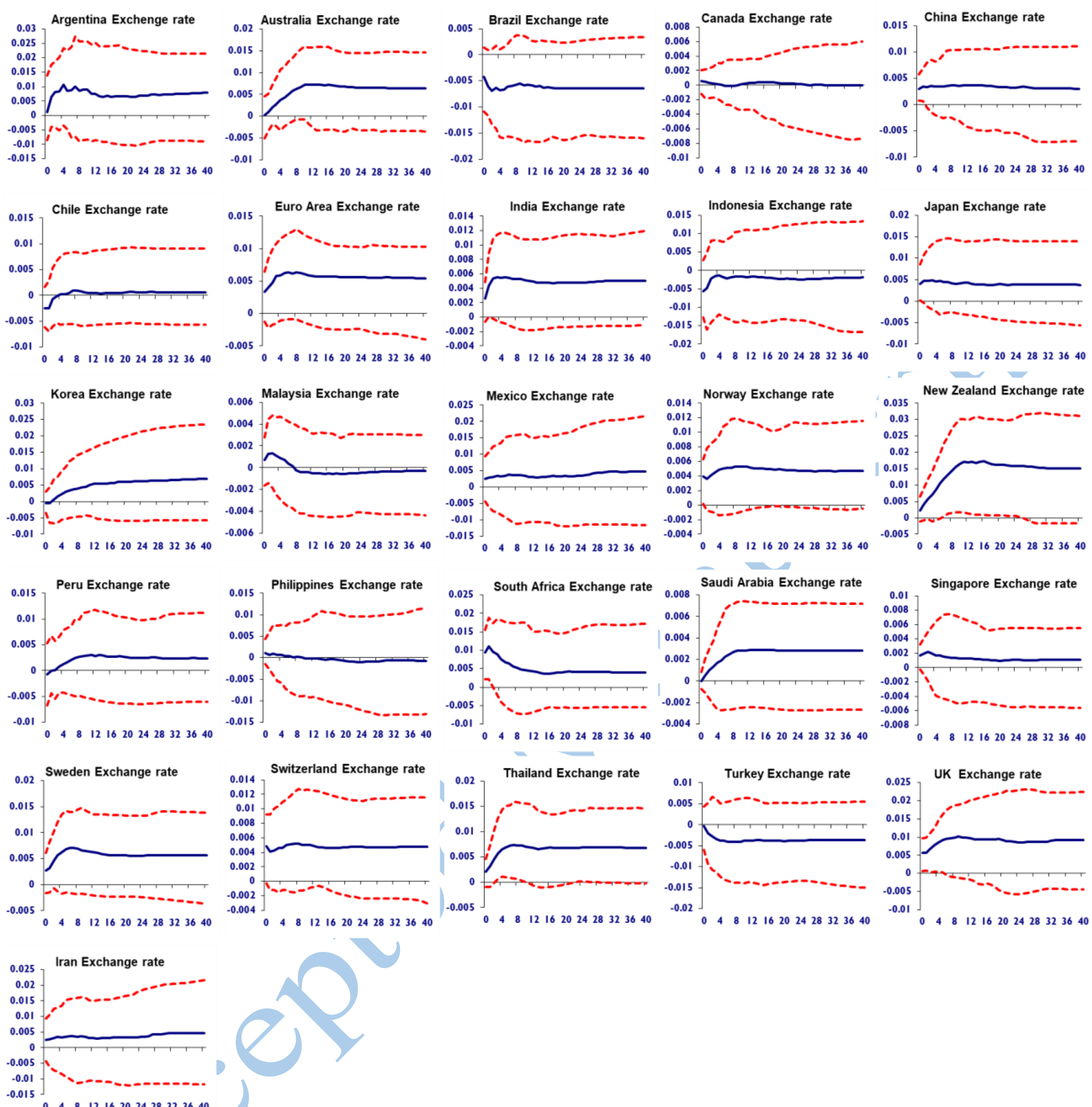


Figure B.2: Structural Impulse Responses of a Negative Unit Shock to Saudi Arabian Oil Supply

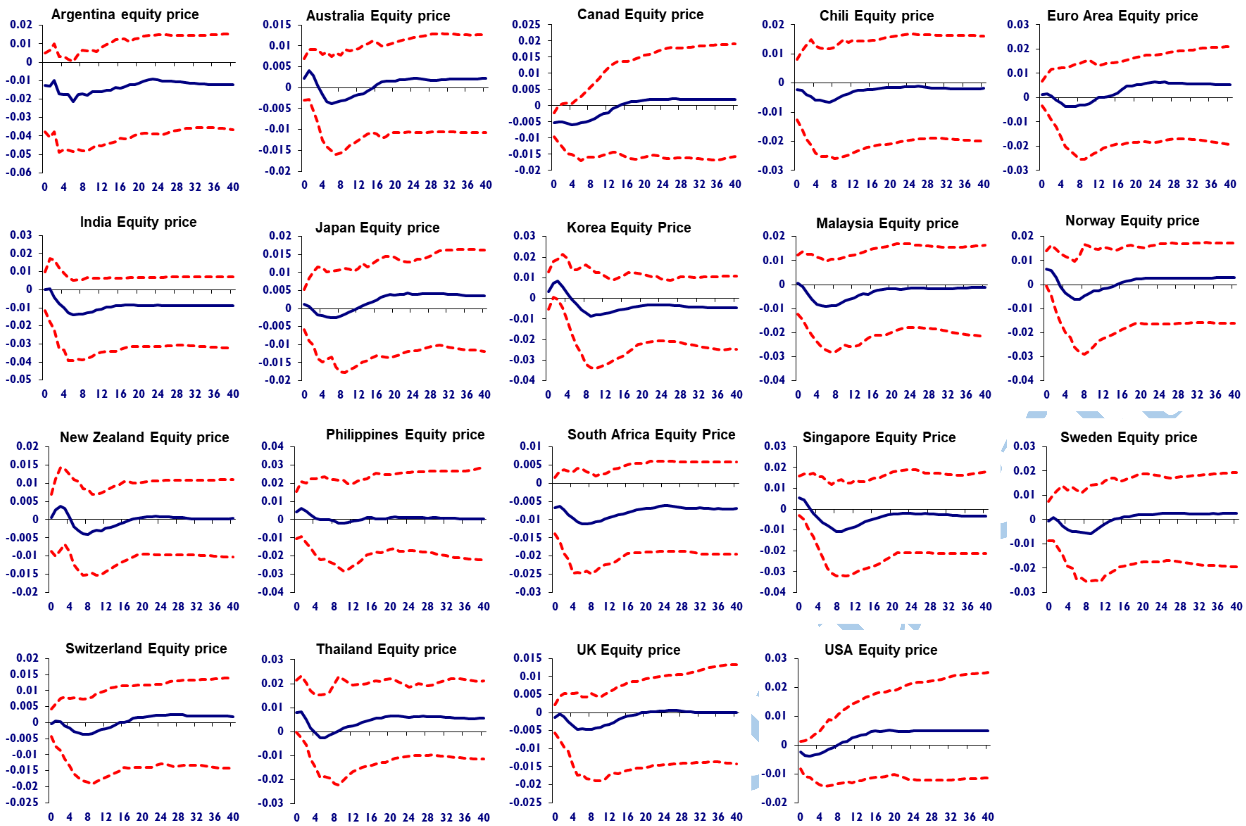


Figure B.3: Structural Impulse Responses of a Negative Unit Shock to Iranian Oil Supply

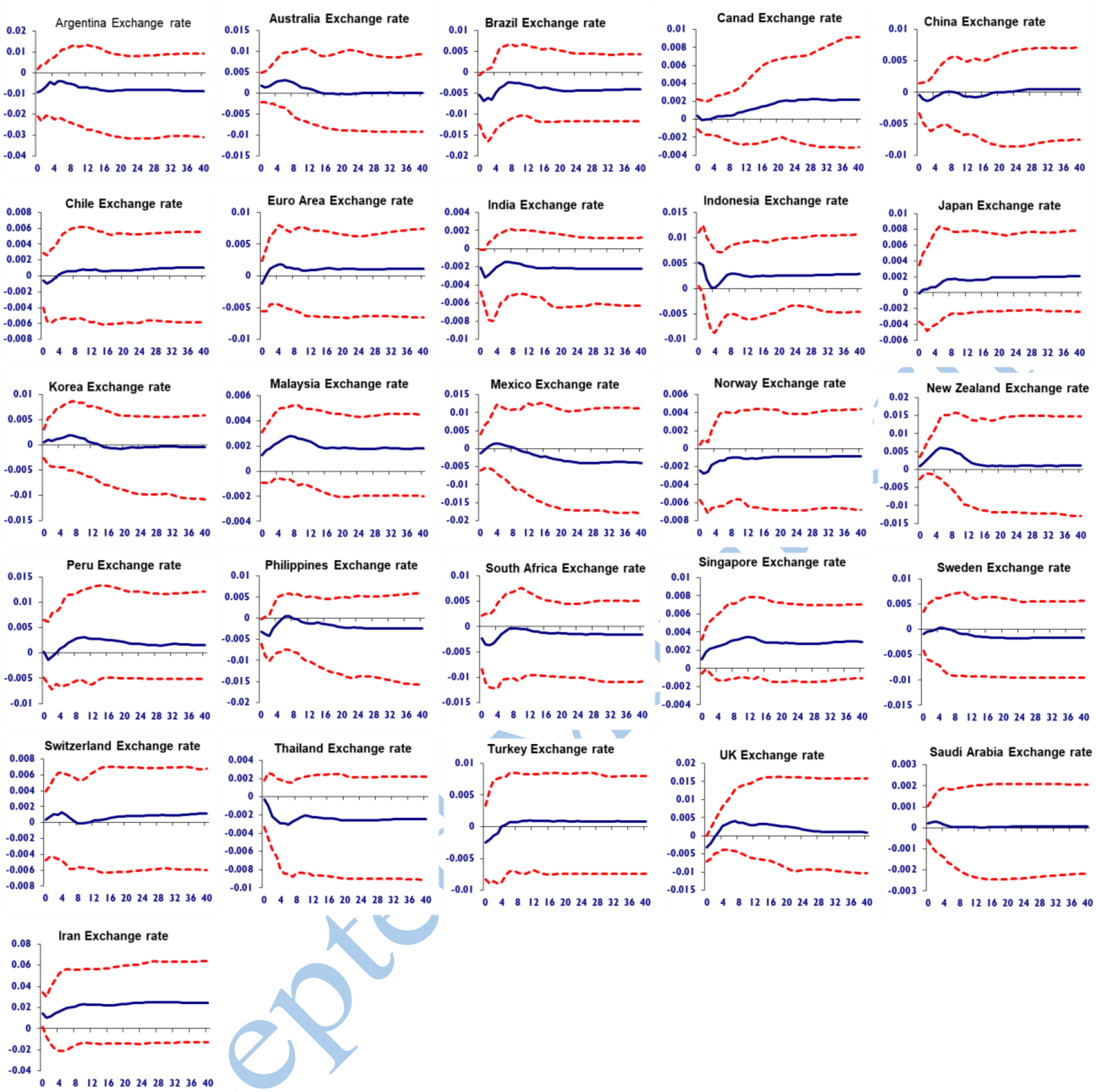


Figure B.4: Structural Impulse Responses of a Negative Unit Shock to Iranian Oil Supply

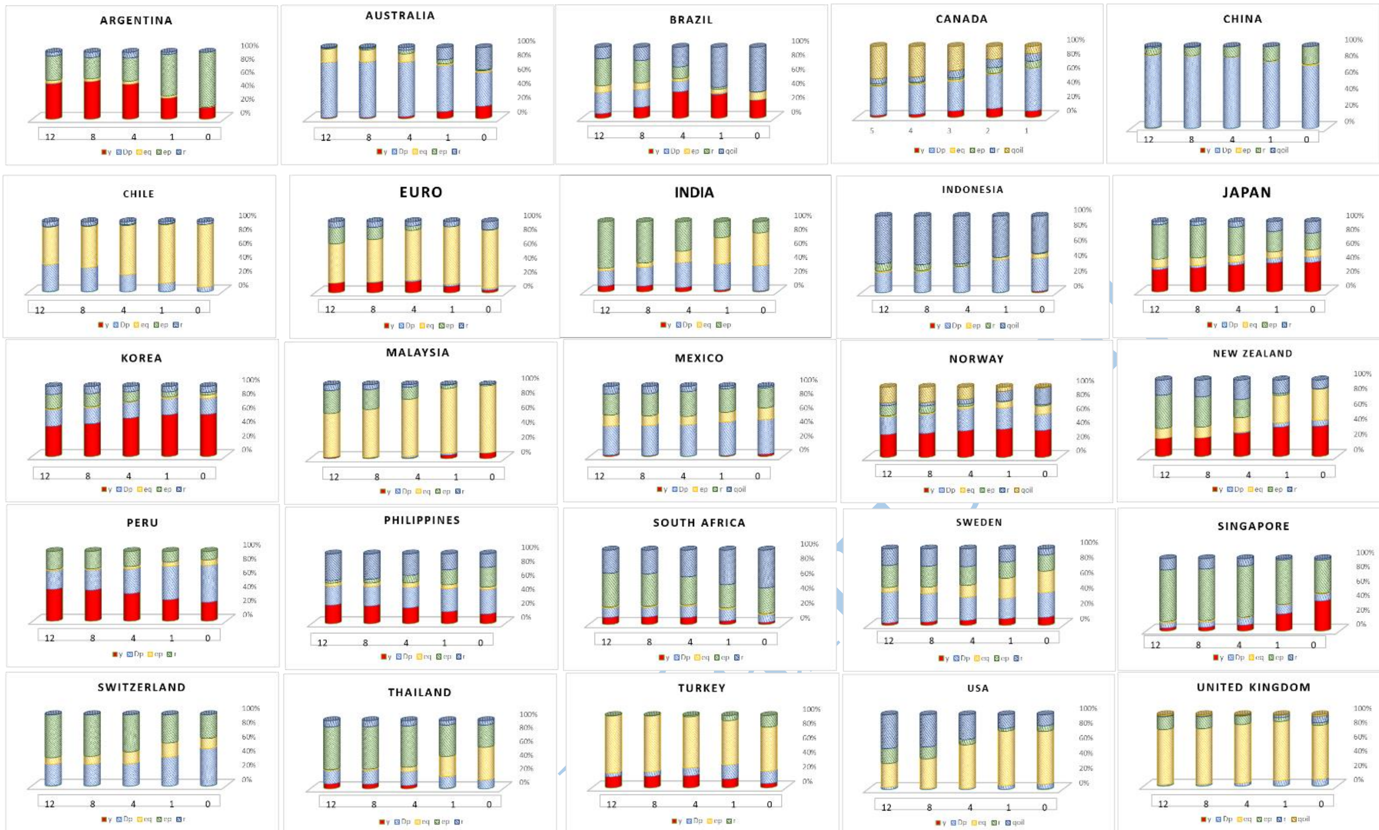


Figure B.5: GDP Variance Decomposition

Table B.1: Lag Order of the country-specific VARX* (S,S*) Models together with the Number of Cointegrating Relations(r) †

Country	VARX* order		Cointegrating relations(r^i)	Country	VARX* Order		Cointegrating relations(r^i)
	S^i	S^*i			S^i	S^*i	
Argentina	2	1	2	Norway	2	1	3
Australia	1	1	3	New zealand	2	1	3
Brazil	2	1	2	Peru	2	1	2
Canada	2	1	3	Philippines	2	1	3
China	2	1	2	South Africa	2	1	2
Chile	2	1	2	Saudi Arabia	2	1	1
Euro Area	2	1	1	Singapore	2	1	1
India	2	1	2	Sweden	2	1	2
Indonesia	2	1	3	Switzerland	1	1	3
Iran	2	1	1	Thailand	2	1	2
Japan	2	1	2	Turkey	2	1	1
Korea	2	1	3	UK	1	1	2
Malaysia	1	1	2	USA	2	1	2
Mexico	1	1	2				

† Notes: $\hat{s}_i$ and $\hat{s}^*_i$ denote the estimated lag orders for the domestic and foreign variables, respectively, selected by the Akaike Information Criterion, with the maximum lag orders set to 2. The number of cointegrating relations ($\hat{r}_i$) are selected using the trace test statistics based on the 95% critical values from for all countries except for Norway, South Africa, Saudi Arabia, and the UK, for which we reduced r_i below that suggested by the trace statistic to ensure the stability of the global model.