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Iranian-Oil-Free Zone and International Oil Prices

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Abstract

One of the main elements of economic sanctions against Iran due to its nuclear and military programs is crude oil exportation restrictions in addition to investment in Iranian energy related projects. Senders of such sanction are interested in understanding the impacts of such embargos on international oil prices. We apply unrestricted Vector Autoregressive (VAR) model, using impulse response (IRF) and variance decomposition (VDA) tools with annual data from 1965 to 2012 to analyze the dynamic response of international oil prices to Iranian oil export sanction. Controlling for the supply of non-Iranian oil and the world GDP per capita, we show that international oil prices respond positively to negative changes of the Iranian oil exports, our proxy of Iran oil sanctions. However, the increasing response of oil prices to the Iranian oil sanction is only significant in the first year after negative shock in Iran oil exports. Beyond the first year following shock, we do not observe a statistically significant response of oil prices.

JEL classification: E37, Q32, Q34, Q38, Q43

Keywords: Oil Price, VAR Model, Sanction, Iran

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‘*If there is a further boost in the sanctions, we will hold our oil for ourselves and we will not export it. We have prepared a plan for this, to run the country without oil revenues. If the US adds to the sanctions, we would cut our exports to the world*’.[1]

(Rostam Ghasemi, Iran's Minister of Petroleum, *Platts*, 23 October 2012)[2]

1- Introduction

In 2011 Mr. Gerecht, a former CIA officer, who is a senior fellow at the Foundation for Defense of Democracies and Mr. Dubowitz who is executive director of the foundation raise this question: “If we buy oil from despotic states, are we somehow complicit in their crimes?” They suggest an Iranian-Oil-Free Zone in order to control ambiguous military and nuclear program of the Iranian state (Gerecht and Dubowitz, 2011). Also recently Eighty-three U.S. Senators wrote President Obama regarding their serious concerns on ongoing negotiations with Iran and necessity of planning for further radical oil sanction if the negotiations fail: “*We must signal unequivocally to Iran that rejecting negotiations and continuing its nuclear weapon program will lead to much more dramatic sanctions, including further limitations on Iran’s exports of crude oil and petroleum products*”.[3]

We are interested in analyzing the dynamic interconnections between Iranian oil supply and global oil prices. How costly will be Iranian Oil Free Zone for global economy? Does Iranian oil supply matter for oil prices? We deviate from existing studies[4] in which the authors examine different political economy effects and consequences of sanctions for Iran. We add to the literature by investigating the external consequences of Iran oil sanctions for oil prices.

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[1] http://www.platts.com/RSSFeedDetailedNews/RSSFeed/Oil/8842808
[2] Also see http://www.bbc.com/news/world-middle-east-16348633
[3] http://www.foreign.senate.gov/press/chair/release/eighty-three-senators-outline-core-principles-of-a-final-agreement-with-iran-in-letter-to-president-obama
[4] See the recent studies of Farzanegan (2011, 2012), Dizaji and Bergeijk (2013), Dizaji and Farzanegan (2014) , Farzanegan (2013), and Naghavi and Pignataro (2013). See Appendix A for a summary of main findings of these studies.

According to the U.S. Treasury, as a result of oil sanction, Iranian crude exports have fallen to about 1 million barrels of oil per day in 2012 from the approximately 2.4 million barrels of 2011.[5] This supply shock raises the following question: *How do oil prices respond to Iranian oil production and export shocks?* The main hope of Western countries for the successful implementation of an oil embargo against Iran is the extra production capacity of Saudi Arabia. Saudi Arabia produces, on average, approximately 10 million bbl/d while its maximum production capacity amounts to approximately 12 million bbl/d. It seems that in the case of maximum production, Saudi Arabia may be able to cover the shortage of Iranian oil exports in the markets. Can this possibility reduce the sensitivity of oil prices in the case of shocks in the Iranian oil supply? Using the VAR models and impulse response analysis, we show that Iranian oil sanctions through negative changes of Iran oil exports can lead to immediate increase in international oil prices. This increasing response is, however, statistically significant in the first year after shock. In other words, positive response of oil process to Iranian oil sanctions will not statistically different from zero in almost all periods beyond the second year following initial negative oil shock. This result is obtained with controlling non-Iranian oil supply (world supply of oil minus the Iranian supply) and GDP per capita of the world. The rest of the paper is organized as follows. Section 2 reviews the theoretical and empirical literature. Section 3 presents our methodology, data, and results. Section 4 concludes the paper with some policy recommendations

2- Review of the theoretical and empirical literature

The theoretical framework of our empirical analysis is explained in the related literature on market power of different members of Organization of the Petroleum Exporting

[5] http://www.eia.gov/todayinenergy/detail.cfm?id=11011

Countries (OPEC). There are several studies on the behavior of OPEC in the oil market. ***Dominant firm behavior*** and ***cartel behavior*** are examples of such models. In our study, we analyze the response of global oil prices to the shocks in negative changes of Iranian oil exports, controlling for the non-Iranian oil supply[6]. For this purpose, the related literature is divided into two categories: the first part discusses dominant firm behavior within the OPEC, while the second part looks at some studies exploring the OPEC from the perspective of one-part cartel behavior.

2.1 Dominant firm model

In this model markets consists of a dominant producer, which has control over the price, and many small firms. Two branches in the literature have discussed this model. One branch considers Saudi Arabia's role as a dominant producer within the OPEC, while the other branch defines a core group of countries as dominant producers.

Saudi Arabia as the dominant firm

Consistent with the dominant firm model, Erickson (1980) analyzes the oil market claiming that Saudi Arabia is the dominant producer which determines the price. Iran, as one of the large producers in OPEC, behaves competitively. In fact, production quantity cannot fluctuate as much for the other large producers as it can for Saudi Arabia. Plaut (1981) notes that "*Saudi Arabia, OPEC's price leader and largest producer, is the moderating force that reflects that country's unique economic role in OPEC.*" Later on, Griffin and Teece (1982) also suggests that Saudi Arabia plays a dominant role, describing it as the "balance wheel" in the market. Maximizing its

[6] Sanction senders to Iran are hoping for cooperation of the Saudi Arabia (as a major oil export within the OPEC) to offset the shortage of Iranian oil and stabilizing the oil market. Therefore, in our literature review we also examine the function of the Saudi Arabia (which is controlled for in empirical analysis under non-Iranian oil supply). For more details on the aims of other main non-Iranian oil suppliers in OPEC to offset shortage of Iranian oil exports see http://dailycaller.com/2011/12/28/official-gulf-states-ready-to-offset-iran-oil/

wealth over time, Saudi Arabia chooses the price path by giving consideration to fringe reaction. Griffin and Nielson (1994) investigate strategies adopted by the OPEC members for the period from 1983 to 1990. According to their empirical results, in the period from 1983 to 1985 Saudi Arabia behaved like a swing producer. That is, Saudi Arabia adjusted its production according to other member's output level. In a tit-for-tat strategy framework involving Saudi Arabia and other OPEC members, they add a nonlinear punishment for cheaters. They find that Saudi Arabia adopts this strategy and, in the case of excessive cheating, stops acting as a swing producer. In his book, Adelman (1995) states that *"The Saudis have acted as what they are: the leading firm in the world oil market"*. Alhajji and Huettner (2000a) explore different economic characteristics for a cartel and try to check the existence of those characteristics in some commodity cartels. They find that none of the specified characteristics were adopted by OPEC. Their study also introduces a model to calculate the elasticity of demand for OPEC's oil. Results show that this elasticity is less than 1 between 1973 and 1994 for OPEC as a whole, while it is greater than 1 for Saudi Arabia. This contradicts both profit maximizing and revenue maximizing conditions in a cartel. In contrast to stable elasticity of demand for OPEC as a whole, elasticity fluctuates a lot for Saudi Arabia which supports the notion of its swing role. In the authors' opinion, OPEC is not a cartel. In their assessment, Saudi Arabia is the dominant player in OPEC, while OPEC membership carries some advantages for other countries. Regular diplomatic relations with other members, sharing the cost of energy market researches, and hearing the voice of small members through OPEC are some of these advantages. They conclude that *"OPEC is composed of Saudi Arabia, dominant world producer, plus several distinct sub-groups"*.

Alhajji and Huettner (2000b) analyze different multi-equation models such as dominant firm model, the Cournot model and the competitive model to investigate whether OPEC as whole or different sub-groups of a cartel exercises any market power on the crude oil market. Statistical results of their model indicate that, compared to the case where Saudi Arabia is considered the dominant producer, all other models are rejected for the period 1973 to 1994.

To investigate the dynamic implications of OPEC behavior, Spilimbergo (2001) tests the null hypothesis of competitive behavior versus the alternative of collusive behavior for the period 1983 to 1991. In his study, collusive behavior is modeled as a market sharing agreement (that is, each OPEC member gets a fixed fraction of total revenue). Empirical results reject the alternative (market sharing cartel) at a very high confidence level. However, Saudi Arabia as a swing producer in OPEC represents an exception to that finding.

De Santis (2003) specifies two different types of behavior, as part of his interpretation of crude oil price fluctuations in the short and long run: quota regime and dominant firm behavior, respectively. In the short run, Saudi Arabian’s oil supply is inelastic, so a large shock in the oil market immediately causes a change in the price. By contrast, dominant firm behavior of Saudi Arabia in the long run causes output to change steadily with little price fluctuation. To quantify the short and long run effects of crude oil market shocks, he constructs a computable general equilibrium (CGE) model for Saudi Arabia both under the quota regime and for the dominant firm framework. The results support his analysis of oil prices overshooting.

Bukenya and Labys (2009) investigate whether Saudi Arabian’s crude oil prices play a leading role for oil prices of other countries in the world oil market. This hypothesis is tested using data for six OPEC and six non-OPEC countries for the period 1970 to 2007. Their overall findings show the existence of long run equilibrium of Saudi Arabian oil prices and prices in the countries under consideration.

A core group as the dominant firm

Another branch of literature tries to show that OPEC power is concentrated in a group of countries called the *core group*. Daly et al. (1982) believe that large reserves, low population, and barren desert geography are common characteristics of members in the core group. Their study identifies Saudi Arabia, Kuwait, UAE, Qatar, and Libya as the core group in OPEC. These core countries have the potential to significantly increase their exports in case of certain economic and political circumstances.[7]

According to Singer (1983), Saudi Arabia and some smaller Arab countries are able to close the gap between world oil demand and other suppliers' production. These countries are able to affect the oil price by adjusting their production. Dahl and Yucel (1990) also believe in the power of a core group in this community and assert that *"OPEC, rather than being a weak cartel, consists of a non-competitive core of swing producers"*. To investigate whether OPEC behaved like a dominant producer from 1973 to 2001, Hansen and Lindholt (2008) apply a multi-equation econometric model. Their study is also aimed at establishing the existence of a dominant producer among OPEC members. They use an Equilibrium Correction Mechanism (ECM) model measuring market power. Their theoretical model follows the dominant producer model outlined in Alhajji and Huettner (2000b). However, Hansen and Lindholt (2008) distinguish between the oil price for the producer and that for the consumer. As part of their logic, they refer to short run elasticity, which is generally smaller than long run elasticity. Due

[7] Iran has already warned the oil exports in the OPEC regarding their efforts to offset shortage of Iranian oil in the market following sanction:
http://www.aljazeera.com/news/middleeast/2012/01/201211595031725845.html

to supply and demand side problems, complete adjustment requires a long time, usually in the order of a few years. Hence, dominant producers have more market power in the short run. Empirical results in Hansen and Lindholt (2008) show that the characteristics of dominant producer fitted the OPEC core group after 1994.

2.2. One part cartel model

In contrast to the first group and its subgroups, where Saudi Arabia plays the role of a dominant producer or forms part of a dominant group, this sub-section discusses OPEC as a one-part cartel. There exist different kinds of cartels in the related literature; some focusing on price and some on volume. Others include restrictions pertaining to customers, patents, products or allocation. In the literature on OPEC behavior there are examples of cartels restricting price or output. Estimating OPEC market behavior, Griffin (1985) tests four alternative hypotheses relating to cartel, competitive, target revenue, and property rights in the period from 1971 to 1983. Different theories of his study are frequently observed to be rejected; however, the partial market sharing cartel was the only one which could not be rejected for all eleven members of OPEC. Based on his empirical results, he states that *"OPEC appears to be a real cartel with at least partially effective output coordination"*. Later on, Jones (1990) extended Griffin's estimates and finds that the partial market sharing cartel regime is the one that most of the OPEC members followed in the period from 1983 to 1988.

In his paper, Loderer (1985) looks at price impact as a condition for any effective cartel. He tests the null hypothesis of "OPEC is unable to affect market prices" versus the alternative of "price impact hypothesis" from 1974 to 1983. His data supports the cartel hypothesis for the period 1981 to 1983. Updating Griffin's (1985) study, Youhanna (1994) empirically tests the competitive and cartel model findings of OPEC behavior for the period 1983 to 1989. The competitive model is rejected for all countries in his study while the partial market sharing model is deemed correct for seven members. Consistent with Griffin's finding, Youhanna's empirical results show that the market sharing cartel model dominates other tested models; however, his results displayed a different level of intensity compared to Griffin's results.

To test if OPEC was an effective cartel between January 1965 and February 1993, Gülen (1996) searched for a long run relationship between each nation's production and OPEC total output. Econometric results show evidence of output coordination for the beginning of the 1980's. Böckem (2004) uses New Empirical Industrial Organization (NEIO) insights to find if OPEC behaves as a cartel. In this approach, demand and supply of oil markets are simultaneously estimated and market power parameters are derived. Then, several theoretical models are considered and the boundaries for the market power parameters are derived. A proper model is one where the theoretical market power boundaries are in line with the estimated market parameters. Results indicate that, for crude oil markets, all models are rejected except the one which characterizes OPEC as price leader cartel.

Kaufmann et al. (2008) attempt to estimate models of crude oil production, highlighting economic and organizational determinants for eight OPEC nations. Results of their study show that quotas have an impact on OPEC oil production both in the short run and long run. In contrast to some other studies, none of the analyzed OPEC members in Kaufmann et al. (2008) show a negative relationship between prices and production. Due to production sharing behavior of all members (except Saudi Arabia) and the role of quotas, their study suggests non-competitive behavior such as cartel behavior for OPEC.

Almoguera et al. (2011) use a simultaneous equation model to find the market structure which can better describe the world oil market from 1974 to 2004. Statistical evidence of their study is consistent with OPEC participating in Cournot competition while non-OPEC producers act as the competitive fringe.

Keeping the view that OPEC members may act as a dominant firm or a cartel, we expect different levels of oil production for each nation in the market. Iran, as the second largest oil producer in OPEC after Saudi Arabia, and the third largest exporter in the world (before recent sanctions), plays an important role in the world oil market. The current oil embargo imposed on Iran will trigger some consequences for the world and a shift in the world oil price can be one of the possibilities. ***If OPEC members behave like in one of the dominant firm model versions, a change in Iranian oil production could not have any effect on the world oil price.*** To the best of our knowledge, Iran has never been mentioned in the group of dominant producers, neither as a dominant producer alone nor as part of dominant core producers. On the other hand, if we consider the whole organization as a one-part cartel, depending on cartel type, a change in price or quantity is expected to be experienced in the market under an embargo.

In next section we show the dynamic of international oil prices response to Iran oil sanctions, controlling for other important factors.

3- Methodology, data and estimation results

Data description

We are interested in examining the dynamic relationship between the Iranian oil export shocks and response of international oil prices. To do this, we use asymmetric shocks in Iranian oil exports. The BP Statistical Review of World Energy 2013 (BP, 2013) provides information on oil production and consumption (barrels per day-bbl/d-). We subtract Iranian oil consumption from its production and calculate the oil exports. The average of Iranian oil exports from 1965 to 2012 is 2.6 millions bbl/d, its maximum once reached 5.5 millions bbl/d (in 1974) and its minimum was recorded in 1981 at 730,000 bbl/d. In our analysis we are interested in negative changes of quantity of Iranian oil exports. Thus, we follow Mork's (1989) definition to claculate the negative changes in quantity of Iranian oil exports:

$$oilexpgn = \min(0, oilexpg_t - oilexpg_{t-1})$$

where *oilexpgn* is negative changes in the Iranian daily oil export (1000 bbld/d), *oilexp* is log (Iran oil exports (bbl/d)). The growth of oil export (*oilexpg*) is then calculazed by 100*($oilexp_t$-$oilexp_{t-1}$). We use logarithm of average international crude oil prices in real prices of 2012 (US dollars per bbl) which is published by the BP (2013). Average of crude oil prices from 1965 to 2012 is $ 46.46 per bbl, its maximum in 2011 was $114 and its minimum in 1970 stood at $11. We also control for the world oil supply (exluding Iran). The oil prices can be also driven by total oil supply. A fully specified model would therefore include non-Iranian oil supply. We use world oil production (1000 bbl/d) in logarithmic transformation using BP (2013). Finally, global economic growth also shape the global oil markets, thus we include logarithm of real GDP per capita of world from the World Bank (2014) in our VAR model. The highest real GDP per capita growth of world happened in 1973 (4.3%), while the lowest growth recorded in 2009 at -3.3%. We use annual data from 1965 to 2012 for our analysis.

Methodology

We estimate a multivariate unrestricted vector autoregressive (VAR) model (see Sims, 1980)[8] using the "decreasing oil exports of Iran" as a shock variable and crude oil

[8] We prefer unrestricted VAR to structural VAR since the latter is "*very often misspecified*" (Tijerina-Guajardo and Pagán, 2003).

global oil prices as the main response variables in addition to controlling for non-Iranian oil supply and world income per capita. Following equation shows the VAR model:

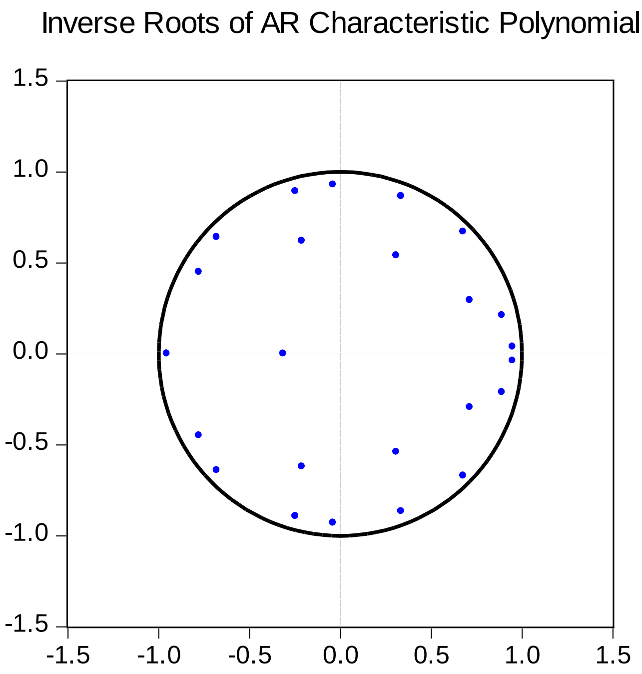
$$y_t = A_1 y_{t-1} + \cdots + A_p y_{t-p} + Bx_t + \varepsilon_t$$

Where $y_t$is a vector of k endogenous variables, x_t is a vector of d exogenous variables, A_1,…, A_p and B are matrices of coefficients to be estimated, p is the optimum number of lags, and ε_t is a vector of innovations . These innovations should be uncorrelated both with their own lagged values and with all of the right-hand side variables. One of the major advantages of using the VAR is addressing the endogeneity issue due to strong interconnections between oil prices, oil supply and global economic growth. All variables in the VAR are endogenous which mitigate prior invalid restrictions on variables. We use impulse response (IRF) and variance decomposition (VDA) analytical tools on the basis of estimated VAR model in order to respond to our research question.

By using the IRF we can measure the size and statistical significance of global oil prices to one standard deviation increase in absolute negative changes of Iranian oil exports (e.g., from -1% to -2%). The IRF shows the response of oil prices after initial negative shock in Iranian oil export in forthcoming years. To judge about statistical significance of such response we report 68% confidence intervals around the main response (see Sims and Zha, 1999 who recommend this). We employ 1000 Monte Carlo simulations to build these confidence intervals. The response is said to be statistically insignificant when the confidence intervals include the horizontal zero line.

We also use the VDC tool. Using VDC, we study the relative importance of negative changes of Iranian oil exports in explanting the variance of global oil prices, besides non-Iranian oil supply and world economic growth. A shock in Iranian oil exports directly affects the variable itself but also it transfers to other variables in the VAR system with time lags. Selecting the optimum lag is also important. We use 6 years lag of variables in the VAR system which is recommended on the basis of Akaike information criterion (AIC). Before presenting and discussing the IRF and VDC results, we need to make sure that the estimated VAR model is correctly specified. There are two main post-estimation tests: the first test is VAR stability condition check. For this purpose we look at the AR Roots Graph (see Figure 1).

Figure 1. VAR Stability Condition Check



Note: No root lies outside the unit circle. VAR satisfies the stability condition.

This shows inverse roots of the characteristic AR polinominal (see Lütkepohl, 1991). The VAR model is said to be stationary or stable if all roots have absolute value less than one and lie inside the unit circle (IHS Global Inc., 2013, p. 556). In the case of VAR instability some key statistics such as impulse response error bands will not be reliable. In our model, as is shown in Figure 1, there are no roots lying on the unit circle (or outside of it), and this suggests that our model is stable. In other words, the influence of the shock for all variables decreases over time. The second test is related to the VAR residual serial correlation. We use Autocorrelation LM Test (see Johansen (1995, p. 22) for the formula of the LM statistic). Results are shown in Table 1. The null hypothesis of no serial correlation of order 7 cannot be rejected. This provided more assurance that we do not have a specific problem with omitted relevant variables in the VAR system.

Table 1. VAR residual serial correlation

VAR Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h
Sample: 1965 2012
Included observations: 41

Lags	LM-Stat	Prob
1	17.62	0.35
2	7.54	0.96
3	14.76	0.54
4	22.69	0.12
5	16.18	0.44
6	13.12	0.66
7	22.42	0.13

For calculating the impulse responses we use the Cholesky ordering in which the first variable affects other variables contemporaneously and get affected by them with lag. Income per capita in the world is the first variable in Cholesky ordering: changes in global economic growth affect demand and supply in oil markets and oil prices contemporaneously and get affected by them with lag. The second variable in ordering is non-Iranian oil supply which its changes also shape Iranian oil supply and export. Finally, oil prices got affected by oil supply and global economic growth and are affecting earlier variables in ordering with some lags. Oil prices are to a great extent the most endogenous variable in the VAR system: they are very sensitive to political and economic factors. Oil exports and supply are less flexible and therefore are ranked earlier than oil prices. [9]

Results

Figure 2 shows the response of international real oil prices and other variables to a one standard deviation increasing in the absolute negative changes of Iranian oil export quantity in the next five years after initial shock. The most interesting response is related to reaction of oil prices. The immediate response of oil prices to Iran oil sanction shock is predicted to be increasing and statistically significant in first year after shock. The price response remains positive till the 5th year after shock. However, for most parts of this time period it remains statistically insignificant. The major challenge for oil market facing decreasing Iranian oil export is in short time. One of the main cooling factors at the time of Iran oil sanctions is the role of other oil suppliers such as Saudi Arabia in filling the gap of Iranian oil in the market. This is evident in response of the non-Iranian oil supply to negative shocks in Iran oil exports. In mid-term the oil production of rest of world shows an increasing and statistically significant response to falling Iranian oil exports. This will have moderating role in reducing oil market stress at the time of Iran sanctions. Iranian oil exports sanctions do not also show a dampening effect on the average of growth in world. Response of income per capita in the world is even increasing during the 2 and 4 years after Iranian oil sanction shock. This response is statistically significant in the 3rd year after shock. Insignificant response of oil prices in mid-term to Iran oil sanction through he offsetting role of other oil suppliers impedes any serious negative shock to global economic growth.

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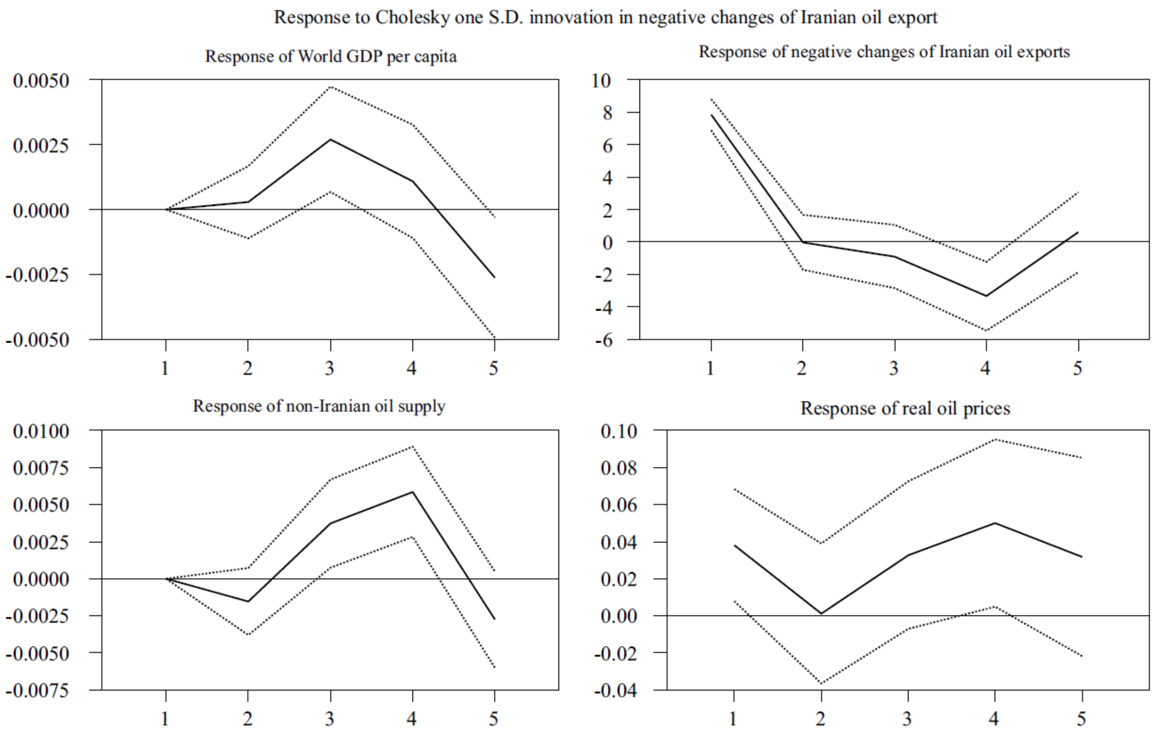
[9] We have also used generalized impulses methodology as suggested by Pesaran and Shin (1998) which is independent of ordering of variables. The results are similar to our Cholesky ordering.

Figure 2. Responses to negative Iranian oil exports shocks



Note: The graphs show impulse responses of variables to one-standard-deviation shocks in negative changes in Iranian oil export quantity. The dotted lines represent ±1 standard deviation. The deviation from the baseline scenario of no shocks is on the vertical axis; the periods (years) after the shock are on the horizontal axis. The vertical axis shows the magnitude of the responses. All variables are used in logarithmic form.

The VDC analysis results are also shown in Table 2. We show the percentage variance of each variable which can be explained by changes in other variables in the VAR system during the years after initial shock. The larger is the percent variance of a specific variable due to changes of another variable, the more important is the latter variable. Looking at variance decomposition of real world oil prices, we observe some general patterns: the role of negative changes in Iranian oil exports in explaining the variance of world oil prices during the first 5 years after shock is fluctuating around 5%, while the relative importance of two other variables namely non-oil Iranian oil supply and world GDP per capita is increasing over time. In the 5th year after shock, negative changes of Iranian oil exports explain 5.17% of variance of oil prices, while the same figure for non-Iranian oil supply and world economic growth are 8.93 and 12.09%.

Table 2. Variance decomposition analysis

Variance Decomposition of real oil prices				
years ahead	real oil prices	negative changes in Iranian oil exports	non-Iranian oil supply	world GDP per capita
1	93.40	4.65	0.46	1.49
2	93.47	3.01	0.68	2.84
3	91.37	4.34	1.42	2.88
4	76.78	5.19	3.64	14.39
5	73.81	5.17	8.93	12.09
Variance Decomposition of negative changes in Iranian oil exports				
years ahead	real oil prices	negative changes in Iranian oil exports	non-Iranian oil supply	world GDP per capita
1	0.00	78.43	17.72	3.85
2	5.49	48.66	34.41	11.44
3	6.40	46.41	32.41	14.79
4	5.80	49.42	29.64	15.13
5	9.36	46.41	28.96	15.28
Variance Decomposition of non-Iranian oil supply				
years ahead	real oil prices	negative changes in Iranian oil exports	non-Iranian oil supply	world GDP per capita
1	0.00	0.00	66.89	33.11
2	0.25	0.73	49.66	49.36
3	0.82	3.65	42.30	53.24
4	0.82	9.42	39.21	50.55
5	1.03	9.91	36.46	52.60
Variance Decomposition of world GDP per capita				
years ahead	real oil prices	negative changes in Iranian oil exports	non-Iranian oil supply	world GDP per capita
1	0.00	0.00	0.00	100.00
2	5.80	0.05	0.00	94.14
3	4.35	3.18	3.38	89.09
4	3.63	2.99	5.84	87.55
5	3.35	4.77	5.40	86.47

The short term explanatory power of shocks to Iranian oil exports are more important compared to other variables in the system in explaining oil price variance. However, the most parts of changes in oil prices are explained by the past own innovations.

Variance decomposition of negative changes of Iranian oil exports shows the increasing importance of non-Iranian oil supply and world GDP per capita in the subsequent 5 years after initial shock. This also fits into our theoretical discussion in section 2.

Variance decomposition for the non-Iranian oil supply shows the relative importance of world economic growth in explaining its forthcoming variations. The importance of world GDP per capita in explaining the variance of non-Iranian oil supply is increasing from 33% in the first year after shock to 52% in the 5th year. Finally variance of world GDP per capita is mostly explained by its own past innovations.

4- Concluding remarks

Sanctions on Iran due to its nuclear and military ambitions have amplified by including energy industry of Iran. In particular, embargos on the Iranian crude oil by major western economies is the highlight of such international initiatives to change political behavior of Iranian government. There are uncertainties about the response of international oil prices to proposals such as Iranian-Oil-Free Zone. Although atomic negations have entered into a new phase after election of new government in Iran but still there is significant pressure inside of the US law making institutions to impose more significant restrictions on Iranian oil exports. Key question which we examine in this analysis is the response of international oil prices to the Iranian oil sanctions. Following Farzanegan (2011) and Dizaji and Bergeijk (2013) in using negative changes of Iranian oil exports as a proxy for oil sanction shock, we investigate the response of oil prices, controlling for global economic growth and non-Iranian oil supply. Our impulse response functions based on VAR modelling of annual data from 1965 to 2012 show the immediate increasing and statistically significant response of oil prices to Iran oil sanctions. This response during the first year after shock, however, loses its statistical significance in the next years following shock.

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Appendix A. Studies related to the political economy of Iran's sanctions

Study	Subject	Data and method	Main results
Farzanegan (2011)	analyze the dynamic effects of oil shocks on different categories of the Iranian government expenditures	VAR Model, IRF, VDC, annual data 1959-2007	1. Significant negative response of military and security spending to increasing shocks in "negative changes" of oil revenues in Iran. 2. Sanctions via channel of decreasing oil revenues may affect military budget of Iran 3. Response of other social spending to oil shocks is not significant.
Farzanegan (2012)	analyze the response of the Iranian economy to shocks in its military budget	VAR, IRF, VDC, Granger Causality, annual data 1959 to 2007	1. Response of economic growth to a one standard deviation increasing shock in the military spending growth rates is positive and statistically significant for the short and middle run. 2. Energy sanctions and recent direct military sanctions not only may limit the military spending of the Iranian state, but will also dampen the economic growth, i.e. two goals with one shot!
Farzanegan (2013)	Effects of the sanctions on the Iran shadow economy	Qualitative anaylsis	Significnat increase of the shadow economy of Iran under economic sanctions
Dizaji and Bergeijk (2013)	analyse the dynamic economic and political impact of an economic sanction (case of Iran)	VAR, IRF, VDC, annual data 1959 to 2006	1. A reduction of oil and gas rents creates economic costs that act as incentives to move towards a more democratic setting. 2. However, this effect is only significant in the first two years and turns negative after six to seven years, as adjustment of economic structures mitigates the economic and political impact of the sanctions.
Dizaji and Farzanegan (2014)	examine how quality of political institutions affects the distribution of government budget and how development of government spending in major sections shapes the political institutions in Iran	VAR, IRF, VDC, annual data 1960 to 2006	1. a shock in positive changes of democratic quality of institutions leads to negative and statistically significant response of military spending and positive and statistically significant response of education expenditures in short term. 2. If sanctions are successful to change the political behavior of Iran in short run (Dizaji and Bergeijk, 2013), then we can also expect to see a reduction in allocated budget for military in Iran.