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Reinvestigation of Oil Price-Stock Market Nexus in Iran: A SVAR Approach

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Abstract

In this paper we investigate the effect of oil price shocks on stock market index in Iran, by using of a structural VAR (SVAR) approach. We used four variables in the model namely Kilian index, global oil supply, real oil price and real stock market index. The data are monthly and spanning the period 1997M10-2014M12. We identify the effect of four different shocks on stock market including oil supply shock, aggregate demand shock, other oil-specific shock and other stock-specific shock. Empirical evidences from impulse response functions (IRFs) indicate that oil supply shock is not significant, and the impact of other three shocks persists for about 3, 6 and 2 months respectively. Variance decomposition (VD) of stock market index indicates "other stock-specific shock" is the most important explainer of its variations. These findings are consistent with the findings of other oil-exporting countries including Saudi Arabia, Kuwait, Mexico, Norway, Russia, Venezuela and Canada except the effect of oil supply shock in variance decomposition of stock market index.

Keywords: Iran, Oil Price, Stock Market, Structural VAR.

1. Introduction

The relationship between stock market prices and oil prices has drawn considerable attention in recent decades. This issue has many reasons. First, oil has remained a major source of world energy accounting for about 34% of the world's energy needs (IEA, 2008). The International Energy Agency (IEA) projects that oil will provide 30% of the world's energy mix in 2030. Second, oil price is susceptible to high volatility due to supply shocks and therefore, the risk and uncertainties occasioned by oil price volatility usually affect investor's portfolios particularly, portfolio managers seeking to make optimal portfolio allocations .The theoretical underpinning for the relationship between oil price and stock returns is usually premised on the fact that oil prices can affect stock

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prices directly by impacting on future cash flows or indirectly through an impact on the interest rate used to discount the future cash flows (Afees A. Salisu and Tirimisiyu F. Oloko, 2015). Oil price generate more income for oil-exporting countries due to the low price elasticity of crude oil demand (Jung and Park, 2011). But in oil importing countries it can cause supply shocks and inflation. Iran is one of the main oil exporting countries and is one of the OPEC members. Iran’s economy is highly dependent to oil revenues and such as other oil exporting countries Dutch disease is one of the economical challenges of this country. Although in recent years because of decreasing of oil price and sanctions government has intended to other income sources such as taxes, but dependence to oil revenue and its effect in the structure of this economy is not negligible. Oil price has significant effects on Iran’s foreign income and also on other financial sections. The above mentioned points highlight the importance of this study. The main goal of this paper is to investigate the oil price shocks on the stock market index in Iran as an oil exporting country. Although this issue has been studied by other researchers but the main contribution of this paper to the past literature is employing of structural VAR (SVAR) methodology. The remainder of this paper is organized as follows. In section two we review some of the past studies, in section three we introduce our model and the data, in section four we obtain the empirical results and analyze them and in the last section we add up the results.

2. Review of Literature

In this section we review some of past studies about Iran and other countries. Many studies have been done about co-movements of oil price and stock market. We can divide these studies in two different categories, studies for oil exporting and oil importing countries. Many of these studies investigated the USA economy, perhaps because of its powerful financial market and also because the USA is one of the largest oil consumers in the world. The results of empirical works on investigation of oil price shocks on stock prices are not consistent each other. For example Chen et al. (1986) argue that oil prices do not affect the trend of stock prices, while Jones and Kaul (1996) indicates a negative association. Kilian and Park (2009) find evidence that the impact of oil price shocks on equity returns varies significantly from one industry to another, depending on the underlying causes of the oil price shocks.For this reason in recent years many researchers focused on oil price effect on industry or sectoral level (Elyasiani et al., 2011; Scholtens and Yurtsever, 2012; Lee et al., 2012).

Hosseini Nasab et al. (2011) examined the effects of oil price shocks on stock returns of Tehran stock exchange with data which covers February 1997 until August 2009.They employed wavelet analysis and markov switching autoregressive (MS-AR) approach. The results showed that oil price shocks positively affect stock returns during bull markets whether with high or low volatility. However oil price shocks have a negative correlation with stock returns during recession phase of stock return with high quality.

Monjazeb and Gohari (2013) investigated impact of oil exports income on Tehran stock exchange dividend and price index (TEDPIX). They employed quarterly data for the period of 1997-2009. They employed linear and linear-logarithmic models with OLS estimator. They used different variables such as oil export incomes, the world price of gold, GDP of Iran, real investment of private sector and dummy variable. The results indicate that the linear model is preferred model. And according to linear–logarithmic model, the logarithm of cash, the price index of Stock market with a lag, Logarithm of oil export incomes of Iran, the exchange rate and the dummy variable affect TEDPIX in Iran.

Abbasinejad and Ebrahimi (2014) investigated the effect of oil shocks on Tehran stoch exchange. They employed markov-switching model and also HP filter, GARCH model and wavelet analysis for investigation. Comparision of results showed that wavelet method has more accurate results. Furthermore results show that oil price increase don’t have significant effect on stock return.

Sunil K. Mohanty et al. (2011) examined Oil price movements and stock market returns in Gulf Cooperation Council (GCC) countries. Their findings showed that at the country level, except for Kuwait, stock markets have significant positive exposures to oil price shocks. At the industry level, the responses of industry-specific returns to oil shocks are significantly positive for only 12 out of 20 industries. Their study also provides evidence that oil price changes have asymmetric effects on stock market returns at the country level as well as at the industry level.

Yudong Wang et al. (2013) examined oil price shocks and stock market activities for oil-importing (US, Japan, Germany, France, UK, Italy, China, Korea and India) and oil-exporting (Saudi Arabia, Kuwait, Mexico, Norway, Russia, Venezuela and Canada) countries. They employed structural VAR methodology for investigation. Their main finding can be summarized as follows: First, the magnitude, duration, and even direction of response by stock market in a country to oil price shocks highly depend on whether the country is a net importer or exporter in the world oil market, and whether changes in oil price are driven by supply or aggregate demand. Second, the relative contribution of each type of oil price shocks depends on the level of importance of oil to national economy, as well as the net position in oil market and the driving forces of oil price changes. Third, the effects of aggregate demand uncertainty on stock markets in oil-exporting countries are much stronger and more persistent than in oil-importing countries. Finally, positive aggregate and precautionary demand shocks are shown to result in a higher degree of co-movement among the stock markets in oil-exporting countries, but not among those in oil-importing countries.

Sadorsky (1999) estimated a vector auto-regression model to study the relation between oil price changes and stock returns in the U.S. He found that both oil price changes and oil price volatility play significant roles in affecting stock returns.

Basher and Sadorsky (2006) analyzed the impact of oil price changes on 21 emerging stock market returns (Argentina, Brazil, Chile, Colombia, India, Indonesia, Israel, Jordan, Korea, Malaysia, Mexico, Pakistan, Peru, Philippines, Poland, South Africa, Sri Lanka, Taiwan, Thailand, Turkey, and Venezuela) over the period 1992–2005 using daily, weekly, and monthly data. They provide evidence that oil price shocks have significant impacts on stock price returns in emerging markets.

Park and Ratti (2008) examined the effects of oil price shocks and oil price volatility on stock returns in the U.S. and 13 European countries (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, the Netherlands, Norway, Spain, Sweden, and the U.K.) using a vector autoregressive model and monthly data for the period 1986–2005. They concluded that oil price shocks have a significant impact on stock returns. Their results also showed that the effects of oil price shocks on stock prices vary among countries.

Kilian and Park (2009) related stock returns to measures of demand and supply shocks in the world crude oil market. They employed monthly data for the US economy over the period 1973:01 to 2006:12. They found the following three results: a negative response of stock returns to an oil-market specific demand shock, a positive effect of a global demand shock on stock returns, and an insignificant effect of oil supply shocks on stock returns.

3. Data and Methodology

In this study following the some of the recent researchers (Kilian and Park, 2009; Yudong Wang et al., 2013; David C. Broadstock and George Filis, 2014) we employ structural VAR (SVAR) methodology. Structural VAR models have four main applications. First, they are used to study the expected response of the model variables to a given one- time structural shock. Second, they allow the construction of forecast error variance decompositions (FEVD) that quantify the average contribution of a given structural shock to the variability of the data. Third, they can be used to provide historical decompositions that measure the cumulative contribution of each structural shock to the evolution of each variable over time. Finally, SVAR models allow the construction of forecast scenarios conditional on hypothetical sequences of future structural shocks (Waggoner and Zha, 1999; Baumeister and Kilian, 2012). We include four different variables in the model for investigation namely:lwos, lrtse, lrop and KI. lwos is logarithm of total world oil supply (thousand barrels per day), lrtse is logarithm of real Tehran stock exchange index (we adjusted nominal index by the CPI index of Iran to get real index), lrop is logarithm of real OPEC reference basket price, KI is Kilian index which released by Lutz Kilian (2009). Kilian index is a proxy for real global economic activity. This index is based on dry cargo freight rates, to estimate the scale of global economic activity as a proxy for global oil demand. We obtained this index from his webpage. Although some of researchers used real GDP (Hamilton, 1983; Rotemberg and Woodford, 1996) or industrial production (Papapetrou, 2001) but in recent decade many researchers employed Kilian index in the model because of its different advantages. This index provides more detailed information on the dynamics of global economic activities, since it is calculated on monthly basis while the other two measures are published quarterly or annually in most cases.

All data are monthly and spanning the period 1997M10-2014M12. The data were obtained from different sources: OPEC organization, U.S Energy Information Administration (EIA), Federal Reserve Bank of Saint Louis and Tehran stock exchange. All data used are in natural logarithm form except Kilian index. In this study we include OPEC reference basket price as a proxy for oil price, because Iran is one of the OPEC members and also Iran’s oil price and OPEC reference basket price of oil are highly correlated, further more we adjusted it’s nominal price with CPI of the USA to get real price. In this step we must identify integration degree of the variables, to get this we can employ different unit root tests such as Augmented Dickey Fuller (ADF), Philips Perron (PP), KPSS and etc. We use ADF unit root test in this study. Table 1 displays the results, as we can see all of the variables are I(1) in the level but their first differences are I(0) or stationary. Therefore we include the first difference of the variables in the model.

Table 1. ADF Unit Root Test Results

variable	ADF-stat.	C.V[2] (5%)	variable	ADF-stat.	C.V (5%)
Lrtse(C[1])	-1.364	-2.875	dLrtse(C)[3]	-8.995	-2.875
Lrtse(C,T)	-1.773	-3.431	dLrtse(C,T)	-8.968	-3.431
Lrop (C)	-1.678	-2.875	dLrop (C)	-10.323	-2.875
Lrop(C,T)	-2.421	-3.431	dLrop(C,T)	-10.335	-3.431
Lwos(C)	-0.450	-2.875	dLwos(C)	-12.445	-2.875
Lwos(C,T)	-3.331	-3.431	dLwos(C,T)	-12.427	-3.431
KI (C)	-2.765	-2.875	dKI (C)	-10.451	-2.875
KI(C,T)	-2.709	-3.431	dKI(C,T)	-10.456	-3.432

1. C indicates intercept and T indicates a time trend.
2. C.V indicates critical value at 5% significance level.
3. d indicates first difference.

Thereafter we can use structural VAR (SVAR) model of the form:

$$A_0 Y_t = a_0 + \sum_{i=1}^{p} A_i Y_{t-i} + \varepsilon_t \tag{1}$$

where Y_t is [Dlwos Dki Dlrop Dlrtse]/ In Equation (1) A_0 represents the [4×4] contemporaneous matrix used to identify the structural relationships, A_i are [4×4] autoregressive coefficient matrices, ε_t is a [4×1] vector of structural disturbances, assumed to be serially uncorrelated and p denotes the order of the SVAR model. The covariance matrix of the structural disturbances takes the following form:

$$E[\varepsilon_t \varepsilon_t'] = D = \begin{bmatrix} \sigma_1^2 & 0 & 0 & 0 \\ 0 & \sigma_2^2 & 0 & 0 \\ 0 & 0 & \sigma_3^2 & 0 \\ 0 & 0 & 0 & \sigma_4^2 \end{bmatrix} \tag{2}$$

Estimation of the SVAR is often done using a reduced form VAR obtained by multiplying both sides of Equation (1) with A_0^{-1}:

$$Y_t = c_0 + \sum_{i=1}^{p} B_i Y_{t-i} + e_t \tag{3}$$

where $c_0 = A_0^{-1} a_0, B_i = A_0^{-1} A_i, e_t = A_0^{-1} \varepsilon_t$ .The reduced form errors e_t are therefore linear combinations of the structural errors ε_t, with a covariance matrix of the form $E[\varepsilon_t \varepsilon_t'] = DA_0^{-1} DA_0^{-1}$. The structural disturbances can then be derived by imposing suitable restrictions on A_0^{-1}. Following Kilian and Park (2009) and Yudong Wang et al. (2013) we decompose the structural innovations by defining $e_t = A_0^{-1}\varepsilon_t$, specifically

$$e_t = \begin{bmatrix} e_{1t}^{\text{global oil production}} \\ e_{2t}^{\text{global real activity}} \\ e_{3t}^{\text{real oil price}} \\ e_{4t}^{\text{real stock index}} \end{bmatrix} = \begin{bmatrix} D_{11} & 0 & 0 & 0 \\ D_{21} & D_{22} & 0 & 0 \\ D_{31} & D_{32} & D_{33} & 0 \\ D_{41} & D_{42} & D_{43} & D_{44} \end{bmatrix} \begin{bmatrix} \varepsilon_{1t}^{\text{oil supply shock}} \\ \varepsilon_{2t}^{\text{aggregate demand shock}} \\ \varepsilon_{3t}^{\text{other oil-specific shock}} \\ \varepsilon_{4t}^{\text{other stock-specific shocks}} \end{bmatrix} \tag{4}$$

For choosing of appropriate number of lags in VAR (p) model we can use different criterias such as Likelihood Ratio (LR), Final Prediction Error (FPE), Schwartz Bayesian Criterion(SBC), Akaike Information Criteria (AIC) and etc. According to AIC and FPE we choose 2 of lags for the model.

We can relate the shocks to the structural innovations as follows:

1. Oil supply shocks are innovations in oil supply.
2. Aggregate demand shocks are innovations in global economic activity which cannot be explained by oil supply shocks.
3. Other oil-specific shocks are innovations in crude oil prices which cannot be explained by oil supply shocks or aggregate demand shocks.
4. Other stock-specific shocks are innovations in stock prices which cannot be explained by the three shocks above. (Yudong Wang et al. 2013). There are different assumptions behind of these restrictions, The first assumption is that, in the short term, the innovations in oil supply do not respond to the changes in aggregate demand, oil price, or stock price.

With this assumption, we can treat the oil supply shocks as exogenous.

Some of the rationales behind this assumption are as follows:

1. The existence of monopoly in the crude oil markets (OPEC's behavior) implies that, to a certain extent, oil supply is exogenously controlled by

several large producers. The political events that lead to a temporary reduction in oil production are usually not predictable.

2. Oil production projects are capital-intensive and time-consuming. This characteristics lead to a very low price elasticity of oil supply in the short term (Mu and Ye, 2011). The second assumption is that while the global economic activity responds to oil supply shocks almost immediately, it takes more than a month for the global economy to react to other oil-specific shocks. Finally, the last assumption is that other oil-specific shocks can be explained by the changes in 'precautionary demand', which is induced by the expected shortfall in oil supply (Yudong Wang et al., 2013).shocks classified as 'other stock-specific shocks' may be caused by many other factors related to the stock markets, such as changes in interest rates or exchange rates that are discussed in Basher et al. (2012), and Jung and Park (2011).

4. Empirical results

In this section we analyze impulse response functions (IRFs) to investigate the response of a certain variable to the shocks. We compare the results with the empirical finding of Yudong Wang et al. (2013) study

For oil-importing and oil-exporting countries.As we know Iran is an oil-exporting country and we only compare Iran's results with oil-exporting countries including Saudi Arabia, Kuwait, Mexico, Norway, Russia, Venezuela and Canada.

Figure 1 illustrates the effect of oil supply shock to real stock market index. As we can see this response is not significant. This result is consistent with the results of some of other oil exporting countries including Kuwait, Saudi Arabia, Russia, Venezuela and Mexico. Moreover this result is consistent with the results of Jung and Park (2011) who examined the linkage of oil price and stock market for Korea and Norway.

Figure 2 illustrates the response of stock market to aggregate demand shock. This shock increases the stock market index for about 3 months. This result is similar to other oil exporting countries (Kuwait, Saudi Arabia, Russia, Venezuela and Mexico). Yudong Wang et al (2013) findings indicate that this effect become insignificant within 1 year. Growth in global economic activity and higher oil demand will also result in a transfer of wealth from oil-importing countries to oil-exporting countries. Thus, the positive impact of aggregate demand shocks on the stock market returns is greater and more persistent in oil-exporting countries.

Figure 3 displays response of stock market to shocks specified as 'other oil-specific shocks', which are associated to oil price changes which cannot be explained by changes in oil supply or demand. Alquist and Kilian (2010) relate the other oil-specific shocks to precautionary demand induced by the expectation of a shortfall in oil supply. This response persists about 6 months. This result is consistent with the result of other four oil exporting countries (Canada, Saudi Arabia, Norway and Russia) and therefore further strengthens the findings in the previous literature.

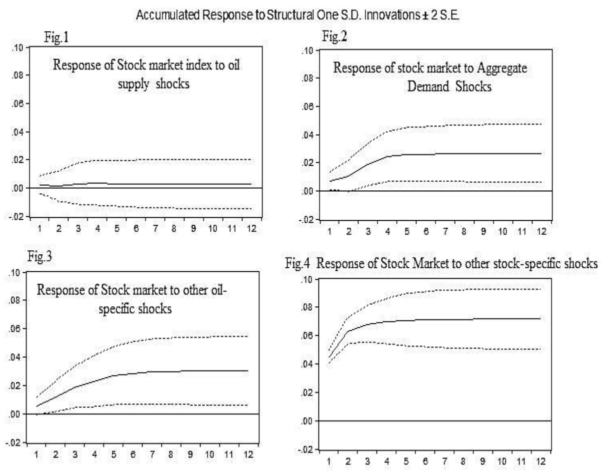
Figure 4 illustrates the response of stock market index to shocks classified as ‘other stock-specific shocks. This response persists about 2 months. This result is similar to the results of Kuwait, Canada and Mexico. To quantify the contributions of oil price shocks to variations in stock market, we employ the variance decomposition (VD) method.

Table 2 displays the variance decomposition result for stock market index. The result shows that “other stock-specific shocks” can explain more than 88 percent of the variations in stock market index. Oil supply shock can explain less than 1 percent of the variations of stock market. The share of other shocks is more than 5 percent for a 12 months period. These results are very similar to the results of Yudong Wang et al. (2013) for oil-exporting countries (Saudi Arabia, Kuwait, Mexico, Norway, Russia, Venezuela and Canada) except the effect of oil supply shock, because in those countries this share is more than 1 percent in stock price variations. This difference may be attributed to Iran’s situation in oil supply. Iran is one of the biggest oil suppliers in the world and can adjust its production to mitigate the shocks in world oil supply.

Table 2.Variance Decomposition of Real Stock Market Index

Period	S.E.	Shock1*	Shock2	Shock3	Shock4
1	0.007764	0.194763	2.136665	1.376941	96.29163
2	0.007843	0.210820	2.330582	2.886002	94.57260
3	0.008174	0.319162	4.869663	4.393716	90.41746
4	0.008202	0.319845	5.869511	5.061159	88.74949
5	0.008209	0.319814	5.941320	5.502334	88.23653
6	0.008211	0.319536	5.934633	5.640978	88.10485
7	0.008212	0.319930	5.935206	5.668634	88.07623
8	0.008212	0.320312	5.937794	5.674445	88.06745
9	0.008212	0.320323	5.938231	5.676036	88.06541
10	0.008212	0.320323	5.938211	5.676445	88.06502
11	0.008212	0.320324	5.938208	5.676529	88.06494
12	0.008212	0.320327	5.938213	5.676545	88.06492

*.Shock1, Shock2, shock3 and shock4 indicate oil supply shock, aggregate demand shock, other oil-specific shock and other stock-specific shock respectively.



5. Conclusions

In this paper we examine the relationship of oil price shocks on stock market. We employ structural VAR (SVAR) methodology which proposed by kilian and park (2009) and monthly data which covers 1997M10-2014M12.We include the following variables in the model: Kilian index, global oil supply, real oil price and real stock market index. We use impulse response function (IRF) and variance decomposition (VD) to investigate the response of stock market to oil price shocks and to quantify the contributions of oil price shocks to variations in stock market respectively. According to IRFs oil supply shock has not significant effect on stock market. The effect of other shocks including aggregate demand shock, other oil-specific shock and other stock-specific shock persists 3, 6 and 2 months in a 12 months period. Variance decomposition of real stock market index indicates "other stock-specific shock" is the most important explainer of its variation with more than 88 percent and oil supply shock can explain its variations less than 1 percent. Other shocks can explain it about 5 percent. Comparison of Iran's results specifically IRFs with other oil exporting countries including Saudi Arabia, Kuwait, Mexico, Norway, Russia, Venezuela and Canada show the results are similar. Except effect of oil supply shock in variance decomposition of real stock market index. As we mentioned in the review of literature section Kilian and Park (2009) find evidence that the impact of oil price shocks on equity returns varies significantly from one industry to another, depending on the underlying causes of the oil price shocks. It seems that this issue can be the subject of future researches.

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