7. AN EVALUATION OF ASYMMETRIC AND SYMMETRIC EFFECTS OF OIL EXPORTS SHOCKS ON NON-TRADABLE SECTOR OF IRANIAN ECONOMY

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Abstract

This study analyzes the relationship between changes in crude oil exports and non-tradable and tradable sections to investigate Dutch Disease syndrome in Iran by applying a rolling linear regression and a VAR approach. We find a co-movement of oil exports with construction and service variables from the rolling regression. The non-linear model reveals that oil exports movements cause asymmetric reaction of construction, service and other variables under study. The variance decomposition shows that crude oil exports contribute to the variability of the key variables. We find a strong relationship between oil exports changes and tradable sector. Decreases in oil exports appear to play a greater role in construction variation than oil exports increases. For variable of service, positive oil shock plays a considerable role as a source of variable fluctuations. Moreover, we observe Dutch Disease through reactions of key variables to oil exports changes.

Keywords: non-tradable sector, Dutch Disease, oil shocks, rolling regression, VAR

JEL Classification: C32, Q43, N60

1. Introduction

Oil revenues play a notable role in structure of oil-exporting countries. Fluctuations of oil shocks have undesirable macroeconomic impacts in many countries. Iran is OPEC's second-largest producer after Saudi Arabia. In 2007, Iran produced approximately 4.1 million barrels per day of total liquids, of which roughly 3.8 million barrels per day was crude oil, equal to about 4.5 percent of the global production.

The economy of Iran is dominated by oil and gas exports which constituted government revenue, notably much part of export earnings spend on price controls

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and subsidies, particularly on food and energy. Thus, despite efforts in the 1990s toward economic liberalization, government spending has been high. High oil prices in recent years have not eased economic hardships. The unique role of oil revenues in the structure of government budgets distinguishes the Iranian economy from others. Possible sources of financing the budget include foreign borrowing and withdrawals from the Oil Stabilization Fund. This is like spending oil revenues directly and has strong effects on the economy. Considering the high rigidity of current government expenditures in Iran, any significant negative oil shocks will worsen the budget deficit of the government and create pressures for the whole economy. The remarkable feature of vulnerability of Iranian economy can be perceived in the reduction in tradable sector and its inevitable consequences. Considering heavy reliance of Iranian economy on oil and gas revenues, analyzing its effects on the economy is crucial.

The results of the study may serve as a possible aid for policymakers in responding to oil shocks in order to lessen the role played by external factors and, also, to isolate the economy from oil revenue volatility and instability.

The plan of the paper is as follows: section two reviews the literature covering asymmetric oil effects, section three discusses methodology and data, the fourth section presents empirical findings. Finally, conclusions are offered in section five.

2. Previous Literature

In an attempt to clarify the poor act of the US economy in the 1970's, researchers took much notice of relationship between oil price shocks and economy. In particular, Hamilton (1983) points out that U.S. post-war recessions are mostly led by oil price shocks. Mork (1989), Hooker (1996) and Hamilton (1996) make substantial contributions to this literature.

Following Hamilton, some researches addressed the question of whether there is a stable relationship between macroeconomic variables and oil price. Some of them have argued that the instability of the relationship is due to misspecification in modeling, so that researchers have tried to suggest different functional forms (linear and nonlinear) which signify factual relationship.

Mork (1989) investigate the likelihood of an asymmetric reaction to oil price decreases, as well as increases. The outcomes showed that GNP was correlated with the conditions of the oil market. Mork offers the specification of an oil price shock as separate variables for increases and decreases, as follows:

$$Oilp_t^- = min\ [0, (oilp_t - oilp_{t-1})]$$

$$Oilp_t^+ = max\ [0, (oilp_t - oilp_{t-1})]$$

Lee *et al*. (1995) explains that it is not sufficient to investigate the issue of causality of real oil price level to the economy but volatility has to be considered. They introduce a GARCH model of oil price as follows:

$$O_t = \alpha_0 + \alpha_1 O_{t-1} + \alpha_2 O_{t-2} + \alpha_3 O_{t-3} + \alpha_4 O_{t-4} + e_t$$

$$e_t \sim N(0, ht)$$

$$h_t = \gamma_0 + \gamma_1 e_{t-1}^2 + \gamma_2 h_{t-1}$$

$$SOIPI_t = max\ (0,\ ^{e^\wedge}{}_t / \sqrt{}\ h^\wedge{}_t)$$

$$SOPD_t = min\ (0,\ ^{e^\wedge}{}_t / \sqrt{}\ h^\wedge{}_t)$$

Hamilton (1996) responds with the NOPI specification, defined as the difference between the increase in a current period and the highest increase in the previous four quarters, if positive, and zero otherwise. This specification removes price increases which correct recent decreases and captures the shock aspect in the oil price change. Hamilton defined net specification as follows:

$$Oilp_t^+ = max\ [0,\ ((oilp_t)\text{-}max\ (oilp_{t-1\ ...}\ oilp_{t-4}))]$$

Hamilton (2003) claimed that oil price increases are much more significant for predicting GDP than decreases. In addition, oil price changes are less useful for predicting if they go after a period of earlier volatile price. Measures look to be acceptable in the condition that they state an oil shock when oil prices exceed their 3-year peak. Given that the oil price and economy relation are determined by the military conflicts rather than the specific changes in oil prices, that directs the economy into recession. Thus, consumer spending or monetary policy are important than the movements in oil prices themselves. The evidence shows that one should use a nonlinear function of oil price changes if the goal is to predict GDP growth.

Balke, Brown and Yucel (1999) analyze the theory using a VAR model of the US economy and show that oil prices affect interest rates asymmetrically before they affect the output asymmetrically. In considering the key role of oil in output, authors have paid attention to this issue largely among oil-importing countries.

Though, studies on oil-exporting countries are infrequent, Jimenez-Rodriguez and Sanchez (2005) underlined a discrepancy between oil-importing and oil-exporting countries. The econometric findings presented in their study demonstrate negative effect of oil price shocks on economy of oil-importing countries. With regard to the two oil exporters in sample, Norway benefits from oil price increases, while UK suffers a negative impact on GDP growth. Moreover, the non-linear model provides more significant results. Lastly, oil price shocks, together with monetary shocks are found to be the largest source of volatility.

Olomola and Adejumo (2006) discover that oil price shocks do not have significant effects on inflation and output rate in Nigeria. However, the results show that fluctuations in oil prices do considerably affect the real exchange rates.

Giordani, Kohn, Dijk (2007) demonstrate that the class of conditionally linear and Gaussian state-space models offers a general framework for simultaneously handling nonlinearity, structural change and outliers in the time series. Many popular nonlinear time series models, including threshold, smooth transition and Markov-switching models, can be written in state-space form. Consider the general state-space model:

$$y_t = g_t + h_t' x_t + \gamma_t u_t \qquad (1)$$

$$x_t = f_t + F_t x_{t-1} + \Gamma_t v_t \qquad (2)$$

where: y_t is the observed scalar time series variable of interest, xt is the state vector, and the errors ut and vt are assumed to be independent and (multivariate) standard normal.

The system matrices are determined, up to a set of unknown parameters, which is an unobserved first-order Markov process. Many popular nonlinear time series models can be expressed in the form of (1) and (2).

Consider the first order autoregressive (AR) model with a Markov-switching mean:

$$y_t = \mu_t + \phi(y_{t-1} - \mu_{t-1}) + \sigma_e \varepsilon_t \tag{3}$$

$$\mu_t = \nu + \delta K_{\delta t} \tag{4}$$

The model (3)–(4) can be expressed in the state-space form (1)–(2) by setting $X_t = (y_t - \mu_t, \mu_t)'$,u_t =0, v_t =0 and $K_t = K_{\delta t}$ and defining the system matrices as

$$g_t = 0, h_t = (1,1)', \zeta_t = 0, f_t = (o, \nu + \delta K_{\delta t})', F_t = \begin{pmatrix} \phi & 0 \\ 0 & 0 \end{pmatrix}, F_t = \begin{pmatrix} \sigma \\ 0 \end{pmatrix}$$

Consider the first order smooth transition autoregressive (STAR) model:

$$y_t = \phi_{1t} y_{t-1} + \phi_{2t} y_{t-1} \Lambda (S_t; \lambda, c) + \sigma_e e_t$$

$$\Lambda (S_t; \lambda, c) = \frac{1}{1 + \exp(-\lambda (S_t - e))}, \lambda \geq 0$$

This time, by defining the state vector as $X_t = (\phi_{1t}, \phi_{2t})$.Consider the threshold model:

$$y_t = Z_t + \sigma K_{at} a_t$$

$$Z_t = \phi_1 Z_t + \phi_2 Z_{t-1} I\{S_t > e\} + \sigma K_{et} e_t$$

This model can be written in the state-space form of (1)–(2) by setting $x_t = z_t$, $u_t = \alpha_t$, $v_t = e_t$,

$$K_t = (K_{at}, K_{et})', F_t = \phi_1 + \phi_2 I\{S_t > e\}, \Gamma_t = \sigma K_{et}.$$

Al-Gudhea, Kenc, Dibooglu (2007) consider the relationship between upstream and downstream gasoline prices. A formal way to introduce asymmetric adjustment to the model is a Threshold Autoregressive (TAR) Process:

$$\Delta \mu_t = I_t P1 \mu_{t-1} + (1 - 1_t) P2 \mu_{t-1} + \sum_{i=1}^{P} \beta i \Delta \mu_{t-i} + \varepsilon_t \quad I_t = \begin{Bmatrix} 1 \text{ if } \mu_{t-1} \geq T \\ 0 \text{ if } \mu_{t-1} < T \end{Bmatrix}$$

Authors find that transmission between upstream and downstream prices is mostly asymmetric in the momentum model: increases in upstream prices are passed on to downstream prices more quickly than decreases.

Mehrara and Niki Oskoui (2007) find that oil price shocks are the main source of output fluctuations in Saudi Arabia and Iran, but not in Kuwait and Indonesia. Mehrara (2008) concludes that output growth is adversely affected by the negative oil shocks, while oil hikes play a narrow role in stimulating the economy of oil exporters.

Aloui, Jammazi (2009) develop a two regime Markov-switching EGARCH model to examine the relationship between crude oil shocks and stock markets. Authors detect two episodes of series behavior, one relative to low mean/high variance regime and the other to high mean/low variance regime. They use as indicator of oil price movement, the NOPI proposed by Hamilton:

$$NOPI \begin{cases} = oil_t - \max\left(oil_{t-1}, oil_{t-12}, \text{ if } oil_{t-1}, oil_{t-12}\right) \\ = 0 \ \ otherwise \end{cases}$$

The MS-EGARCH (1, 1) model will be written as follows:

$$y_t = \mu_{it} + \eta_i NOPI_{t-1} + \varepsilon_t \qquad \varepsilon_t / I_{t-1} \quad D\left(0_t h_{it}\right)$$

$$In\left(h_{it}\right) = \varpi_i + \phi_i \left[\frac{\varepsilon_{t-1}}{\sqrt{h_{it-1}}} - \sqrt{2/\pi}\right] + \beta_i In\left(h_{it-1}\right) + \delta \frac{\varepsilon_{t-1}}{\sqrt{h_{it-1}}} + \lambda_i NOPI_{t-1}$$

The MS-EGARCH model allows for the relationship between oil price shocks and real stock returns. Evidence shows that the net oil price increase variable play a significant role in determining both the volatility of real returns and the probability of the transition across regimes.

A more recent study of Iran economy was conducted by Farzanegan and Markwardt (2009).They found a strong positive relationship between positive oil price changes and industrial output growth. They identified a marginal impact of oil price changes on government expenditures. Furthermore, they observe the Dutch Disease syndrome through real effective exchange rate appreciation.

3. Methodology

We consider linear and non-linear models to show symmetric and asymmetric effects of oil export. An approach at analyzing possible changes in a linear effect of crude oil exports over time is the use of rolling linear regression. This approach allows for a gradual change in the estimated coefficients of crude oil exports, construction and services in GDP equation by using OLS approach. We consider the following model:

$$Y = C_0 + \sum_{1}^{2} C_t\, OILXP_{t-1} + C_3 CNS + C_4 SRV + e_t$$

where: *Y* indicates *GDP*, *OILXP* indicates oil exports, *CNS* indicates construction and SRV indicates services group. In addition, variables are in level.

The approach of the asymmetric model is an unrestricted vector autoregressive model (VAR). Once the VAR estimates, the role of a variable in making changes in its own value and the value of other variables are evaluated by Forecast Error Variance Decomposition (*VDC*). Variance decomposition provides the variance of forecast errors in a given variable to its own shocks and other variables in the VAR. It allows us to assess the relative importance of oil price shocks to the volatility of the variables. The dynamic reaction of variables to changes can also be observed by applying Impulse Response Function (*IRF*). Impulse response functions allow us to examine the dynamic effects of oil exports shocks on the Iranian economy. It traces over time the expected responses of current and future values variables to a shock in one of the VAR equations. The decomposition method in *IRF* for construction variable is Cholesky, while for service variable is generalized impulses.

We carry out two sets of VAR model. The first model (VAR1) consists of following variables: construction (*CNS*), oil exports decrease (SCOEXD) and increase (*SCOEXI*), public consumption expenditures (*PBEXPN*), imports (*IMP*) and manufacturing (*MNF*). The second one (VAR2) consists of 4 variables: oil exports decrease (*SCOEXD*), increase (*SCOEXI*), index of service (PPISR) and real effective exchange rate (*REER*). We consider the following vector auto regressive model:

$$y_t = c + \sum \Phi_i \, y_{t-i} + e_t$$

where: y_t is a vector of endogenous variables mentioned above, Φi is the ith matrix of coefficients and e_t is the white noise vector.

The full sample consists of quarterly observations extracted from Central Bank of Iran database for 1987:QIV to 2008:QI period. In unrestricted VAR models, the vector of endogenous variable order in VAR1 and VAR2 are as follows, in turn:

[*SCOEXI, SCOEXD, PBEXPN, LIMP, MNF, CNS*]

[*SCOEXI, SCOEXD, REER, PPISR*]

Variables are based on constant local currency. Selecting manufacturing production is due to analyze the effects of oil shocks on real activity and investigate the behavior of tradable section in responding to oil shocks. Our hypothesis is that fluctuations in oil exports have asymmetric affects on construction, imports, manufacturing, real effective exchange rate and index of service. In addition, all variables are in level and the variable of imports is in logarithmic form.

4 .Empirical evidence

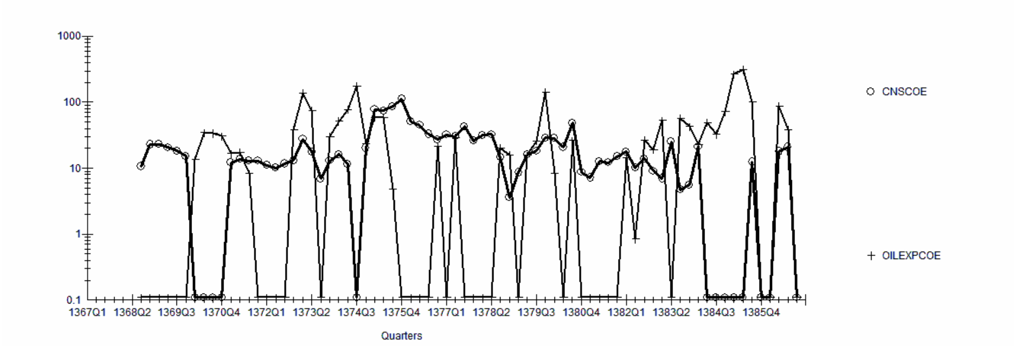
In this section, we empirically assess the effects of oil exports on economic activity. In order to simplify the presentation of the results, we distinguish between linear and non-linear models, focusing on the preferred (scaled) model specification. We first present, under item 4.1, the results of linear model. In item 4.2 we present the results of the scaled model.

4.1. Rolling linear regression

The change in the effects of oil shocks is more likely to have been associated with a more gradual variation over time. This leads us to adopt a more flexible approach. An alternative approach to analyze changes of variables over time is the use of rolling regression. We do this using a moving window of 6 quarters, the *Oy* axis and *Ox* axes shows the sample period and the coefficients magnitude, in turn. In order to check the consistency of oil variable movement with other variables (construction and service), we first compute the regression analyzed in previous section, then plot the graph of coefficient over time (1987:QIV-2008:QI).Variables are in level, while figures used on the Oy axis are in logarithmic form in order to show the movements of graphs clearly. Figures 1 and 2 display the coefficients of construction (*CNSCOE*), services (*SRVCOE*) and oil exports (*OILXPCOE*). Service variable appears sensitive to the oil shock over the entire sample period, but particularly so in the last decade; when oil variable rises remarkably, after two or three quarters service variable rises as well. A similar pattern can be observed for oil and service variables. Construction variable is steadily more muted and persistent over time compared with service variable due to some limits to change the capacity in construction sector. That is why the construction variable shows a more dramatic contrast in comparison with the service variable. It seems that effect of oil changes on service variable is stronger than the effect on construction variable. Overall, Figures 1 and 2 suggest the co-movements of the coefficients of oil exports, construction and services. What we can say is that oil exports affect the non-tradable variables.

Figure1

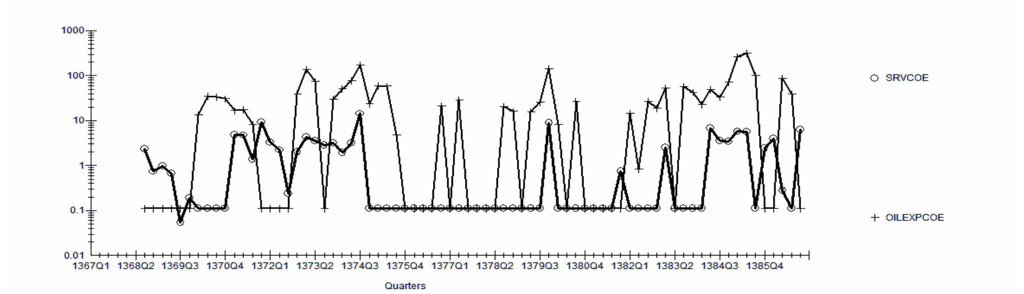
Co-movement of the coefficients of crude oil exports and construction



Source: Results of the model.

Figure2

Co-movement of the coefficients of crude oil exports and service



Source: Results of the model.

4.2. Non linear model

On the basis of the previous literature, we consider three non-linear specifications of oil exports. Such non-linear specifications are the following:

a) Asymmetric specification (Mork, 1989), in which increases and decreases in oil export are considered as separate variables.

$$Oilp_t^- = \min\,[0, (oilp_t - oilp_{t-1})]$$

$$Oilp_t^+ = \max\,[0, (oilp_t - oilp_{t-1})]$$

b) Scaled specification (Lee *et al*., 1995), which takes the volatility of oil exports into account. We proposed the following AR(4)-GARCH representation of oil export:

$$O_t = \alpha_0 + \alpha_1 O_{t-1} + \alpha_2 O_{t-2} + \alpha_3 O_{t-3} + \alpha_4 O_{t-4} + e_t$$

$$e_t \sim N(0, ht)$$

$$h_t = \gamma_0 + \gamma_1 e_{t-1}^2 + \gamma_2 h_{t-1}$$

$$SOPI_t = \max(0, \hat{e}_t / \sqrt{\hat{h}_t})$$

$$SOPD_t = \min(0, \hat{e}_t / \sqrt{\hat{h}_t})$$

where: *SOPI* stands for scaled oil increases, while SOPD stands for scaled oil decreases.

c) Net specification (Hamilton, 1996), where the relevant oil price variable is defined to be the net amount.

$$Oilp_t^+ = \max[0, ((oilp_t) - \max(oilp_{t-1} \ldots oilp_{t-4}))]$$

$$Oilp_t^- = \min[0, ((oilp_t) - \min(oilp_{t-1} \ldots oilp_{t-4}))]$$

We compare the performance of the different specifications considered here in order to focus on the preferred one. This analysis is preceded by an assessment of the relative performance of different non-linear specifications, which allows us to focus on the preferred one. Table 1 in Appendix displays the value of criteria. We look at selection criteria such as the Akaike Information Criterion (AIC) and Schwarz Bayesian Information Criterion (BIC). On the basis of these two criteria, we conclude that the scaled specification (GARCH model) performs better than the other.

For the first step of our analysis we carry out test of stationarity to investigate the existence of unit roots in our statistical series by calculating the Augmented Dickey-Fuller Test (ADF Test) and Philips Peron test (PT). Results of these tests are reported in Table 2 in Appendix.

Considering that the variables of the model follow an I(1) process, we analyze whether there is a long run relationship among these variables. To test this, we employ Johansen co-integration tests, whose results are reported in Table 3 in Appendix. Since all the series are integrated, this suggests a possibility of the presence of co-integrating relationship between oil exports and the Iranian economic variables. The optimal lag length in VAR1 is one. The vector of exogenous variables in this model is given by:

$$Z_t = \{c, s1, s2, s3, dshock\}$$

where: s_i refers to seasonal dummies and dshock refers to all events , namely Iran–Iraq war, 1987:QIV–1988:QIII Kuwait–Iraq war, 1990:QI–1990:QIV, South East Asian financial crisis, 1997:QIII–1998:QIV, September 11, 2001:QIII–2002:QII US–Iraq war, 2003:QI–2003:QIV, which affected the oil market. The optimal lag in VAR2 is one (see Table 4 in Appendix).

We perform the Wald test statistic, which tests the null hypothesis that coefficients of the oil exports are zero in VAR model. Table 5 in Appendix displays the p-values of the Wald test statistic, indicating that we accept the hypothesis that the different oil variables are not statistically significant, except for oil increase in asymmetric specification in VAR1. This means that oil variable does not have a significant direct impact on construction. In VAR2, we accept the hypothesis that the oil export decreases and increases are not statistically significant, except for oil export decreases in asymmetric specification. This means that oil decrease appear to have a significant direct impact on service variable.

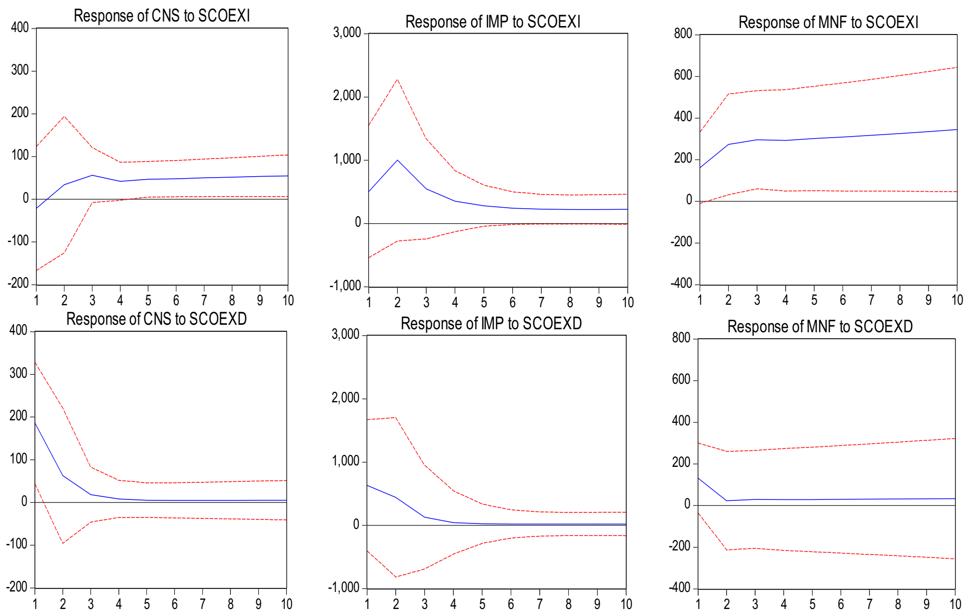
Finally, we perform the Granger test of block exogeneity. We test for whether a given oil variable Granger-causes the remaining variables of the system (see Table 6 in Appendix), obtaining that oil price variables generally Granger-cause the remaining variables of the system at 1% critical level in VAR1, but not in VAR2.

4.2.1. Impulse response functions and accumulated responses

Under this item, we examine the effects of oil export decreases and increases on variables under study in terms of both impulse response functions and accumulated responses of scaled model. The following figures represent the impulse response functions of variables to one standard deviation oil export shock with their corresponding two standard error bands. The Ox axis and Oy axis show the sample period and the magnitude of oil shocks. Figures 3 and 4 represent the impulse response functions of construction, imports, manufacturing, real effective exchange rate and index of service to oil shocks with their corresponding two standard error bands, in turn.

Figure 3

Impulse response function of construction



Source: Results of the model.

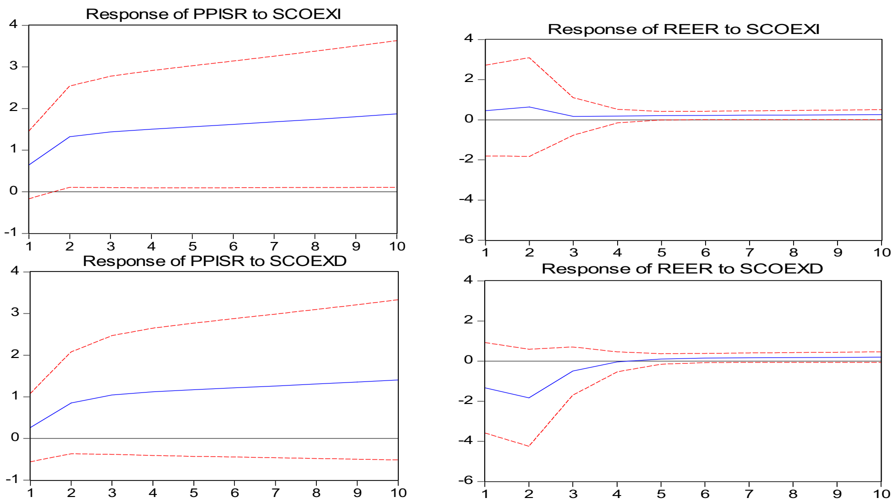
Regarding positive movements in crude oil exports, we observe that the shocks in oil exports growth significantly increase construction in the short and long run, which reaches its maximum value in the 3rd quarter after the initial shock. After the first year, the impulse responses become stable significantly and gradually. After the initial positive shock, imports rises positively and rapidly reaches its maximum value in the 2nd quarter. The variable significantly reaches a steady position in the long run. Manufacturing reacts positively and significantly to the positive initial oil shock in over the entire sample period. The response is due to financing the imports of raw materials and intermediary goods, upon which the manufacturing sector depends roughly. Manufacturing and construction output response to the shock gradually because it takes time to increase their performance due to constraints and limited capacity in these sectors. This confirms the stimulus effect of positive crude oil exports shocks on construction output and the high dependency of industrial output. Industry is supported by government especially, via energy subsidies. Hence, industries will be forced to downsize the business when oil revenue decreases due to essential role of natural recourses revenue to finance the government budget.

In Figure 4, we observe that there is a positive response of service variable to positive movements in oil variable. The graph displays an immediate and considerable reaction in the short and long run. The reaction is statistically significant. This means that the variable exhibits a normal behavior, while it is expected that a positive oil shock has positive effects on index of service growth for an oil exporting country. The second variable (rate of effective exchange rate) significantly and positively reacts to oil increases in the long run. The variable reaches its maximum in the second quarter, although the effect of positive oil shock will decrease in the long run as a result of government's controls on prices and exchange rate. Oil exports hikes led to a real exchange rate appreciation of the rials in the short run.

The explanation for effects of positive oil changes in construction, service, also in manufacturing, imports and real effective exchange rate is through the Dutch Disease phenomenon.

Figure 4

Impulse response function of service



Source: Results of the model.

In Fgures 3 and 4, we also demonstrate the responses of variables to negative changes in crude oil exports. Construction positively and insignificantly reacts, which lead to the difference in terms of the accumulated response to positive and negative oil shocks beyond the short term. As expected, imports fall down and, consequently, manufacturing descend remarkably. They reach a steady position in the medium term. Their responds to negative oil shocks are statistically insignificant. Once oil revenues fall owing to negative oil shocks, the level of imported raw and capital intermediaries, which is mainly financed through oil revenues, will decrease. In connection with this, manufacturing falls too. The reactions of construction, imports and manufacturing to negative shocks show that oil exports decreases negatively affect the economy, a fact that is captured in the results of the impulse-response functions of the variables presented in Table 3. In Figure 4, we observe that there is a positive response of service variable, but not as big as its reaction to oil increases, which lead to the difference in terms of the accumulated responses to positive and negative oil shocks beyond the short term. With regard that services group consists of trade, transportation, financial, real estate, public and social services, it is obvious that services such as the social and public ones will not be cut back during oil decreases mostly. The shapes of the impulse-response functions of service variable to changes in oil decreases and increases are largely similar but different in magnitude. With respect to these reactions, we study the asymmetric respond of service in accumulated terms, as well as the forecast error variance decomposition. Real effective exchange rate reacts negatively and remarkably to oil decrease after initial shock. The effect of negative oil shock will decrease in the long run as a result of government's controls on prices and exchange rate. The variable reaches its minimum value in the second quarter and a steady position in the medium term. Both variables in VAR2 respond to negative shocks insignificantly.

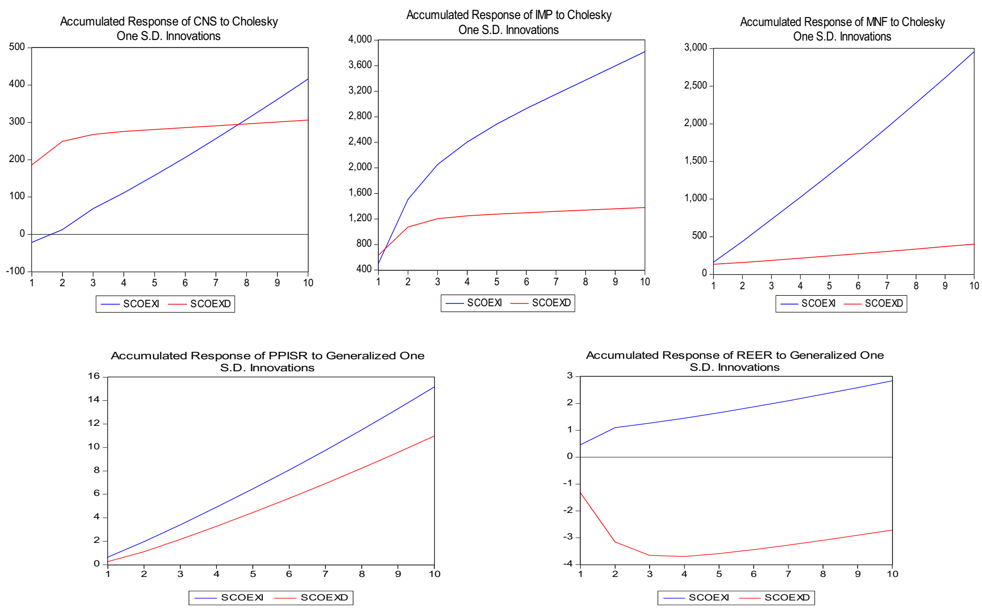
To sum up, the reactions in non-tradable sector via construction and index of service variables and also in tradable sector via imports, manufacturing and real effective exchange rate variables support the hypothesis of the presence of a Dutch Disease syndrome. This supports the presence of asymmetric responses as well.

In order to have a better view of asymmetric responses, we have analyzed combined graphs of accumulated responses of variables. Figure 5 reports the accumulated responses. The reaction of variables to oil increase is positive. As mentioned above, considering the high rigidity of current government expenditures in Iran, any significant negative oil shocks will worsen the budget deficit of the government and create pressures to the whole economy. This can be observed from reactions of key variables to negative oil shock, which is different in magnitude in comparison to their reactions to the positive one. Asymmetric response is the fact captured in the results presented in Figure 5. The different reactions of service variable to oil decreases and increases are not as noteworthy as the other variables. In particular, real effective exchange rate exhibits a surprising behavior. Real effective exchange rate responds to negative and positive oil shocks not only in different magnitudes, but also in opposite signs. The distinctive difference in the responses can be explained in part by the exchange rate appreciation and depreciation, and in part by the different adjustments in inflation. The accumulated reaction of service variable to positive shock is somewhat larger than its reaction to negative one with an accumulated positive gain. Construction variable suffers from stronger positive adjustment than those of the negative one due to the environment and some limits in investment and facilities in this sector. The pattern of import and manufacturing responses are similar to some extent.

We find that one of the key channels playing a role in the effect of oil prices on real activity is related to the real effective exchange rate. Declines in the variables, especially in real effective exchange rate to react oil decreases in comparison with variables' reactions to oil increases support Dutch Disease phenomena. A fact that is captured in the results has highlighted that they reveal that oil shocks can lead to Dutch Disease among oil-exporting countries which highly depend on oil revenue.

Figure 5

Accumulated response of key variables



Source: Results of the model.

4.2.2. Variance decomposition analysis

Tables 1 and 2 present the results of the forecast error variance decomposition, which shows how much of the unanticipated changes of the construction and service variables are explained by different shock in the preferred model. The variance decompositions suggest that oil exports shocks are a source of volatility for construction variable in the model to varying degrees, whereas negative oil shocks have a stronger short and long run role compared to the positive one. While positive oil shocks explain about 0.11-3.91% variable fluctuations during the period, respectively, negative oil price shocks account for 8.76% in the 1st and 6.93% in 10th quarters of variances of variable. The role of industrial GDP (manufacturing) is considerable, which start from 23% to 32% at the end of the period .This shows the relationship of construction and industry. Public consumption expenditures and imports affect construction because they are financed mostly via current revenue of exported oil; those are directly affected by shocks. Accordingly, these variables are one of channel which transfers oil shocks to the economy. The other important aspect of asymmetric oil shocks can be seen in its effects on index of service fluctuations. For variable of services, positive oil shock plays a considerable role as a source of variable fluctuations. Whereas negative shocks explain about 0.016% and 2.43% of variances of the variable in the 1st and 10th quarters, respectively, negative oil shocks give explanation of 3.86-13.8% variable fluctuations for the same period. The past innovations in this variable explain changes from 96% to 83.7%. Real effective exchange rate explains of 0.16-0.1% variable fluctuations.

We present variance decomposition of imports, manufacturing and real exchange rate in Table 7 in Appendix, which shows that positive shock play a stronger role compared with negative shock in explaining the fluctuations mentioned above, except for real effective exchange rate. Negative oil shocks give explanation of 1.94-1.81%, 3.1-0.6% and 3.06-8.1% imports, manufacturing and real effective exchange rate fluctuations, in turn. Positive oil shocks explain 1.23-5.9%, 4.61-14.2% and 0.26-1.06% of variances of the variables, respectively. Our finding on the contribution of oil shocks to variability of the variables under study seems to lie within the Dutch Disease syndrome. This result can in part be interpreted as a weak performance of de-linking fiscal policy from current oil revenue among oil-exporting countries.

Table 1

Variance decomposition of construction variable

Period	S.E.	SCOEXI	SCOEXD	PBEXPN	IMP	MNF	CNS
1	0.746412	0.117127	8.762391	4.979698	5.071369	23.28091	57.78850
2	0.767947	0.378062	8.930340	10.09789	4.707599	22.58069	53.30541
3	0.769560	1.073925	8.684930	9.933923	4.581263	24.30805	51.41791
4	0.769990	1.422477	8.436247	9.938997	4.493368	25.55124	50.15767
5	0.770164	1.837451	8.180869	9.800288	4.454204	26.78128	48.94591
6	0.770266	2.249784	7.927156	9.636745	4.441610	27.96156	47.78314
7	0.770348	2.669094	7.674672	9.455484	4.445911	29.11644	46.63840
8	0.770427	3.088180	7.424487	9.267683	4.459277	30.24989	45.51048
9	0.770508	3.504748	7.177140	9.077601	4.477460	31.36473	44.39832
10	0.770592	3.916877	6.933104	8.887810	4.498041	32.46159	43.30258

Table 2

Variance decomposition of service variable

Period	S.E.	SCOEXI	SCOEXD	REER	PPISR
1	0.703979	3.863973	0.015762	0.164113	95.95615
2	0.713827	9.087707	0.765874	0.172896	89.97352
3	0.714375	11.06868	1.374567	0.152282	87.40447
4	0.714412	12.06795	1.742557	0.136500	86.05299
5	0.714415	12.65852	1.973646	0.125882	85.24195
6	0.714416	13.04572	2.128300	0.118606	84.70738

Period	S.E.	SCOEXI	SCOEXD	REER	PPISR
7	0.714416	13.31815	2.237857	0.113410	84.33059
8	0.714417	13.51970	2.319090	0.109547	84.05167
9	0.714417	13.67446	2.381513	0.106576	83.83745
10	0.714418	13.79675	2.430847	0.104227	83.66817

Source: Results of the model.

5. Conclusions

Many studies on the oil relationship has concentrated on developed oil importing economies. A formal study on the impact of oil shocks on macroeconomics in an oil exporting country such as Iran is still lacking. External shocks namely sanction and oil shocks play an important role in Iran, which is an oil-dependent country. Therefore, aggregate economy is much vulnerable to the shocks. To the best of our knowledge, it is the first study to employ the nonlinear approach in order to assess the asymmetric impact of the oil shocks on non-tradable variables. Through the analysis of results and discussion, we can draw the following conclusions.

We consider linear and non-linear models to show symmetric and asymmetric effects of oil exports. An approach at analyzing possible changes in a linear effect of oil exports over time is the use of rolling linear regression. We observe the co-movements of the coefficients of oil, construction and services. It seems that effect of oil changes on services group is stronger than the effect on construction section.

The approach of asymmetric model is an unrestricted vector autoregressive model (VAR). We carry out two sets of VAR model. The first model (VAR1) consists of following variables: construction, oil exports decrease and increase, public consumption expenditures, imports and manufacturing. The second one (VAR2) consists of four variables: oil exports decrease and increase, index of service and real effective exchange rate. Our hypothesis is that the fluctuations in oil exports have asymmetric affects on variables, which result in the Dutch disease. We consider three non-linear specifications of oil exports, namely asymmetric, scaled and net specifications, in which increases and decreases in oil export are considered as separate variables. On the basis of two criteria (AIC and BIC), we conclude that the scaled specification performs better than the others. Stressing on the preferred model, we examine the effects of oil decreases and increases on variables under study in terms of impulse response functions, accumulated responses and the forecast error variance decomposition.

The results of impulse response functions indicates that the shocks in oil exports growth significantly increase construction, imports, manufacturing, index of service and real effective exchange rate. As expected, we observe that imports fall down and, consequently, manufacturing drops remarkably in responding to negative shocks. Real effective exchange rate reacts negatively and remarkably to oil decrease after initial shock. Construction falls down, while service has the same pattern as it has in responding to positive shock.

In order to have a better view of asymmetric responses, we have analyzed combined graphs of accumulated responses of variables. Asymmetric response is the fact captured in the results of accumulated responses of key variables to negative oil shock, which is different in magnitude in comparison to their reactions to the positive one.

The other important aspect of asymmetric oil shocks can be seen in effects of oil shocks on variable fluctuations. The variance decompositions suggest that negative oil shocks have a stronger role compared to the positive one for construction variable. For variable of service, positive oil shock plays a considerable role as a source of variable fluctuations.

The facts captured in the results of nonlinear model are consistent with the outcome of analyzing the variables by means rolling regression, which confirm that efficient deploying of natural resource revenues to mitigate oil shocks is vital. Hence, the role of the oil stabilization funds in protecting state budgets from external shocks should be important. The rich-resource country such as Iran suffers from a weak and undiversified economy, which results in the Dutch Disease.

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Appendix

Table 1

Relative Performance of the Models

VAR 1

ASYMMETRIC		SCALED		NET	
ASYMMETRIC-AIC	ASYMMETRIC-SIC	SCALED-AIC	SCALED-SIC	NET-AIC	NET-SIC
91.0169	93.1369	71.63625	73.67564	91.63343	93.67282

VAR2

ASYMMETRIC		SCALED		NET	
ASYMMETRIC-AIC	ASYMMETRIC- SIC	SCALED-AIC	SCALED-SIC	NET-AIC	NET-SIC
39.35173	39.98910	16.05346	16.72811	37.44470	38.08207

Table2

Stationarity test

Results of unit-root tests

Model with intercept and trend		Model with intercept		Model without intercept and trend	
ADF	PT	ADF	PT	ADF	PT
CN in levels					
1.409613	-9.145162***	0.014027	-4.199786***	0.999	0.108332
CN in first differences					
-18.19082***	-36.49341***	-18.27437***	-36.30342***	-5.747718***	-28.99311***
oil decrease in levels					
-3.037046	-7.753624***	-3.053618	-7.793944***	-2.069480**	-6.093713***
oil decrease in first differences					
-12.43484***	-19.67799***	-12.52584***	-19.80982***	-12.60048***	-19.95534***
oil increase in levels					
-8.685046***	-8.693300***	-8.719397***	-8.727120***	-7.042358***	-7.143597***
oil increase in first differences					
-8.347538***	-47.32674***	-8.410718***	-47.41056***	-8.470438***	-48.00350***
MNF in levels					
0.608995	-2.757944	2.670722	2.025004	3.663893	5.281631
MNF in first differences					
-4.215758***	-20.48654***	-2.027274	-14.60638***	-1.056675	-12.29393***
Public consumption expenditures in levels					
-2.461714	-9.976662***	-0.843676	-4.652907***	1.299214	0.565656
Public consumption expenditures in first differences					
-14.13364***	-42.96948***	-14.23313***	-42.96248***	-14.05733***	-35.03746***
IMP in levels					
-1.094751	-4.466917***	-0.768492	-3.772444***	0.752566	0.155142
IMP in first differences					
-12.27059***	-19.52449***	-12.30441***	-19.55109***	-12.25207***	-19.30694***
REER in levels					
-4.176998***	-3.216554*	-2.016964	1.374702	1.374702	-1.862020
REER in first differences					
-2.291350	-9.349638***	-2.338061	-8.851812***	-2.159197*	-8.881083***
PPISR in levels					
2.468834	3.057104	3.550335	12.45110	3.280872	19.62937
PPISR in first difference					
-4.863004***	-4.883146***	0.482256	-1.955422	-0.315924	1.625864

*We denote with */**/*** the rejection of the null hypothesis of a unit root at a 10/5/1 percent significant level.*

Table 3

Johansen co-integration tests

VAR1

Trace test	Maximum eigenvalue test
4	3
4	4

Table 4

Optimal lag length

VAR1

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-2631.879	NA	4.32e+25	76.05368	77.01732	76.43645
1	-2441.406	321.0827	5.31e+23	71.64017	73.76018*	72.48227*
2	-2404.845	55.36362	5.46e+23	71.62415	74.90053	72.92557
3	-2354.951	67.00074	4.02e+23	71.22717	75.65992	72.98791
4	-2309.125	53.68247*	3.59e+23*	70.94642	76.53553	73.16648
5	-2267.335	41.78913	4.00e+23	70.78101	77.52650	73.46040
6	-2226.462	33.86638	5.36e+23	70.64178*	78.54363	73.78049

VAR2

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-754.1609	NA	228897.7	23.69253	23.82746	23.74568
1	-493.7106	480.2053*	110.3022*	16.05346*	16.72811*	16.31923*
2	-484.4627	15.89482	137.0651	16.26446	17.47883	16.74286
3	-471.4467	20.74419	152.7987	16.35771	18.11180	17.04874
4	-458.2753	19.34552	171.8808	16.44610	18.73992	17.34975
5	-443.3434	20.06473	186.5647	16.47948	19.31302	17.59575
6	-431.3726	14.58947	227.9631	16.60539	19.97865	17.93429

Table 5

Wald test

P-values of the asymptotic distribution Chi-Squared are reported for the different models considered.H_0: The oil product coefficients are equal to zero in the VAR 1.

ASYMMETRIC		SCALED		NET	
asymi	asymd	scoxi	scoxd	hoexi	hoexd
12.44588	5.630971	4.673754	4.33974	4.234714	7.984328

P-value of the asymptotic distribution chi-squared is reported for the different models considered. H_0: The oil product coefficients are equal to zero in VAR 2.

ASYMMETRIC		SCALED		NET	
asymi	asymd	scoxi	scoxd	hoexi	hoexd
4.058276	74.25196	2.247086	2.809570	2.764093	6.569258

Table 6

Granger Causality in a Multivariate Context (Block-Erogeneity Test)

P-value in VAR 1model are reported

ASYMMETRIC	SCALED	NET
0.0000	0.0000	0.0000

P-value in VAR2 model are reported

ASYMMETRIC	SCALED	NET
0.2494	0.3516	0.2055

Table 7

Variance Decomposition of IMP:							
Period	S.E.	SCOEXI	SCOEXD	PBEXPN	IMP	MNF	CNS
1	0.746412	1.235642	1.937202	4.058883	92.76827	0.000000	0.000000
2	0.767947	4.384084	2.076034	9.974675	81.54983	0.003153	2.012228
3	0.769560	4.977946	1.958549	11.45212	78.93948	0.167510	2.504391
4	0.769990	5.223356	1.910591	11.59862	78.00748	0.407689	2.852261
5	0.770164	5.391150	1.886141	11.52515	77.39431	0.749503	3.053749
6	0.770266	5.516296	1.869057	11.41790	76.84340	1.158203	3.195139
7	0.770348	5.622070	1.853871	11.31916	76.28209	1.615793	3.307015
8	0.770427	5.718559	1.838980	11.23164	75.69574	2.109606	3.405482
9	0.770508	5.811559	1.823843	11.15115	75.08232	2.632729	3.498395
10	0.770592	5.904180	1.808267	11.07389	74.44241	3.181374	3.589880
Variance Decomposition of MNF:							
Period	S.E.	SCOEXI	SCOEXD	PBEXPN	IMP	MNF	CNS
1	0.452116	4.607399	3.097574	0.047894	14.61852	77.62861	0.000000
2	0.466557	9.476207	1.694823	2.317472	10.73578	67.28007	8.495641
3	0.466966	11.80754	1.185362	2.318630	9.272220	65.59657	9.819684
4	0.466998	12.76050	0.919360	2.555487	8.338058	64.72721	10.69938
5	0.467002	13.35890	0.753655	2.716810	7.713690	64.27008	11.18686
6	0.467005	13.74786	0.641493	2.848737	7.266321	63.98520	11.51039
7	0.467008	14.02496	0.560484	2.951884	6.933008	63.79217	11.73749
8	0.467012	14.23182	0.499338	3.033896	6.676491	63.65207	11.90638
9	0.467016	14.39233	0.451606	3.099810	6.473952	63.54539	12.03692
10	0.467020	14.52044	0.413363	3.153540	6.310574	63.46118	12.14090

Variance Decomposition of REER:					
Period	S.E.	SCOEXI	SCOEXD	REER	PPISR
1	0.703979	0.258537	3.053418	96.68805	0.000000
2	0.713827	0.673599	7.950444	91.23402	0.141936
3	0.714375	0.698677	8.259064	90.68122	0.361039
4	0.714412	0.731976	8.245371	90.40807	0.614583
5	0.714415	0.774667	8.219815	90.11510	0.890420
6	0.714416	0.823307	8.197304	89.79321	1.186179
7	0.714416	0.876236	8.175312	89.44638	1.502071
8	0.714417	0.932992	8.152496	89.07551	1.839005
9	0.714417	0.993571	8.128366	88.67996	2.198103
10	0.714418	1.058118	8.102720	88.25859	2.580570

Source: Results of the model.