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The Effect of Oil Price Shocks on Economic Activity in Saudi Arabia: Econometric Approach

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Abstract

This paper is attempt to investigate the effect of oil price shocks on the Saudi's economic activity using annual data (1970-2015) to cover all of oil price shocks; particularly the recent decline in oil prices amid 2014. The vector autoregressive (VAR) and vector error correction model (VECM) were utilized to investigate the long-run and the short-run relationships between variables. The findings suggest a positive and significant relationship between oil prices and the Saudi's GDP in the long run.

Keywords: oil price shocks, GDP growth, Vector autoregressive (VAR), Vector error correction model (VECM)

JEL Classifications: E03, E37, F40

1. Introduction

For the last four decades, tremendous research has been done on how oil prices shocks affect economic activity and related macroeconomic factors. Regarding to oil price producing country as Saudi Arabia, the topic is getting more appealing. Globally, Saudi Arabia has almost one fifth of the world reserve and known to be the world's largest production capacity, and also the world's largest exporter of the net oil based on The US Energy Information Administration (EIA). Moreover, Saudi's oil revenues in 2014 amount to around 71.1% and 87.5% of total exports and total revenues respectively according to Saudi Arabian Monetary Agency (SAMA), annual report (2014). Apparently, oil plays a key role in the economy of Saudi Arabia since it is highly dependent on oil sources and this study is attempt to investigate the impact of oil prices fluctuations on economic activity of Saudi economy and macroeconomic fundamentals as well.

Oil shocks affected most of oil producing countries, especially the gulf region (Mehrara et al., 2006). GDP of Saudi Arabia was expectedly affected by most of the historical oil prices shocks. The first oil price shock was in 1973-1974, where the oil price increased by more than 200%, and; promptly, Saudi's GDP increased from 53,047 million riyals to 159,276 million riyals with almost 200% increase. In addition, on the second oil price shock in 1978-1979, Saudi's GDP increased by 38% from 270,439 to 373,309 million riyals where oil price increased by 24%. The third shock particularly was affecting the gulf countries the most because of the Iraq war in 1990. It has affected most of countries in negative result but surprisingly, Saudi's GDP went up by 13%.

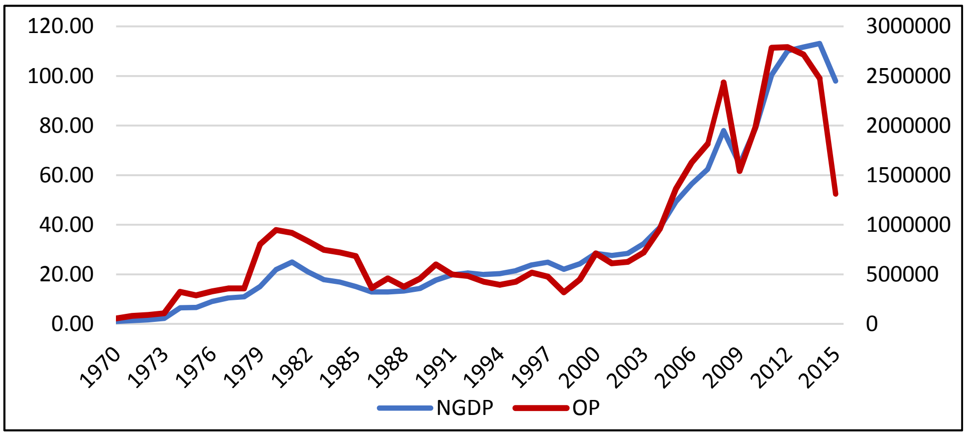

Figure 1. The relationship between oil price and Saudi's GDP (1970-2015)

The forth shock started from 2003 Till 2008 coupled with a dramatic surge in oil prices, followed by a rise in the GDP for most of GCC countries. In Saudi Arabia, the GDP has increased by 16.7% during the period 2003-2004 and oil prices kept increasing until 2008, where Saudi's GDP became 1,7 trillion riyals. The fifth shock was during the period 2008-2009, where oil prices have decreased by 38%, leading the Saudi's GDP to fell from 1,771,203 million riyals in 2008 to 1,384,591 million riyals in 2009 (almost 21.8% decline). Finally, the last shock occurred amid 2014 and Brent crude oil price has fallen below $31 a barrel for 1st time since 2004 as of January, 12, 2015. Moreover, It is clear that there is a strong nexus between oil and Saudi GDP, which suspects a cointegration process.

The Saudi Arabia 2016 budget report was released on Monday, 28 December 2015 (Note 1), reflecting tightening revenue expectations and lower spending on subsidies driven by the decline in oil prices. The budget report points out to three key themes as follows:

1) Better management of expenditure by the implementation of a public finance unit and setting up the National Project Management Agency. These two initiatives will keep expenditures in check;

2) Improving revenue sources and debt capacity by implementing the GCC wide value added tax (FAT) which already all GCC countries have agreed on;

3) Limiting expenditures by subsidy removals as petrol prices gone up by 50 %, up from 0.16 cents (0.6 riyals) to 0.24 cents (0.90 riyals) (Saudi Arabia's 2016 Fiscal Budget – Jadwa).

To the best of our knowledge, this study is among the first papers utilizing both Vector Autoregressive (VAR) and Vector Error correction model (VECM) to gauge the impact of oil price fluctuations on the Saudi economy, particularly on the economic activity.

Through this research, econometric applications as VAR and VECM models have been applied to examine the impact of oil price fluctuations on economic activity of Saudi economy during the period 1970-2015. The rest of the paper is organized as follows: Section 2 provides a brief review of economic literature. Section 3 presents data and econometric methodology. Then, section 4 covers the results of VAR and VECM models. Finally, section 6 delivers the conclusion remarks.

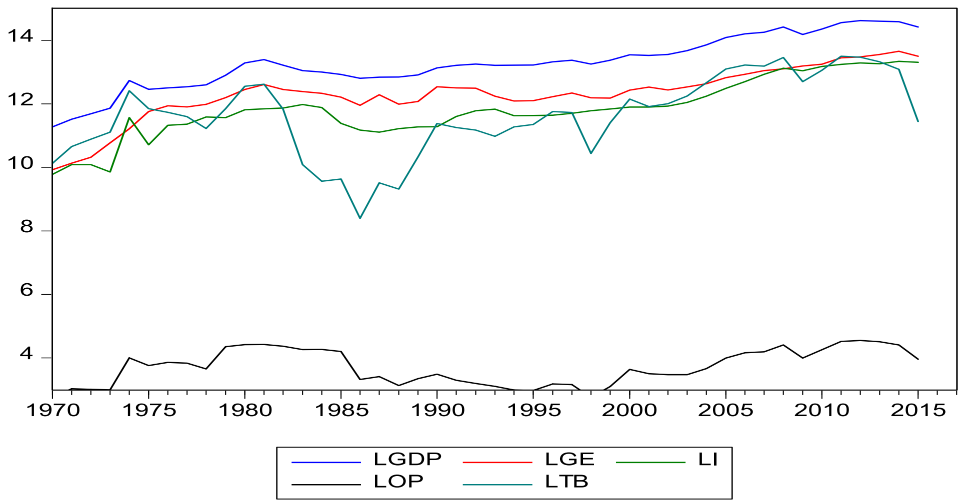

Figure 2. GDP, government expenditure, investment, trade balance and oil prices

Figure 2 illustrates how variables are moving together over time, suggesting an exist of cointegration. Hence, equilibrium should be investigated by conducting vector error correction model (VECM) to draw a conclusion on how variables are moving in the long run. Brent oil prices are moving in similar pattern even in lower levels after taking the logarithm.

2. Literature Review

Various research has be done examining the effect of oil price fluctuations on different economies driven by the importance of oil as a key player on the global economy. Specifically, a great deal of research has been written on the impact of oil prices on developed countries. Hamilton (1983) and Singer (2007) found evidence that oil price shocks resulted in a recession in the US economy. Baumeister (2008) assessed the impact of oil prices on the US's GDP and consumer price inflation. In addition, Hooker (1996) examined oil price shocks and found that the shock on 1973-74 was the most affecting for the US economy, whereas other shocks had fewer disturbances.

Reza et al. (2009) explored the impact of oil price shocks on the Iranian economy. He found a positive nexus between oil prices and both the Iranian's industrial output and the government expenditures. Olomola and Adejumo (2006) found out that oil price shocks have no substantial effect on inflation and output on Nigeria, mitigated by tradable sector shrinking "Dutch Disease". Moreover, Akpan (2009) evaluated the impact of oil prices on the Nigerian's economy by using a VAR model. Results show evidence that the oil prices rise government expenditure, increase inflation and unexpectedly increase the industrial output growth.

In addition, Almulali et al. (2010) investigated the effect of oil prices on Qatar's GDP, using the vector error correction model (VECM). They found that there is a substantial positive effect on Qatar's GDP but with expenses of higher inflation. Altony (1999) empirically investigated the impact of oil price shocks on Kuwait's economy using the VAR and VECM models. With the existence of cointegration and causality, the findings suggest that the fiscal policy (i.e., government stimulant) is the most driver of the economy with absence of monetary policy. Finally, Almutairi (1995) tested the impact of oil on inflation in Kuwait and found that inflation is partly driven by high oil prices.

3. Case of Saudi Arabia

A few articles has been written in economic growth of Saudi economy, testing the key factors that might spur the economic activity. For instance, Tuwaijri (2001) empirically examined the nexus between government expenditures, exports and economic growth in Saudi Arabia during the period 1969-1996. Results revealed that significant and positive relationships exist between variables through government expenditures. Similarly, Al-Obaid (2004) reached the same results highlighting the importance of government expenditures in the Saudi economy in the long-run. Mehrara and Oskuee (2006) explored how the volatility of oil prices feeds in fluctuations at the Iranian's economy and the Saudi's in addition to Indonesia and Kuwait. The study's results indicate that oil prices shocks play a major role on the Iranian's economy and Saudi's but with less impact on Kuwait and Indonesia. The later countries had a successful fiscal policy, mitigating the adverse impact of oil price volatility. Tabala (2009) analyzed the effect of oil price shocks on Saudi and Russian's economies. In Russia, the surge in oil prices raised the state budget revenues substantially and it is found that the Russian economy is growing in a higher pattern than the Saudi economy driven by higher households consumption. In addition, Alkhathlan (2013) empirically investigated the effect of oil production on economic growth of the Saudi economy during the period 1971-2010. The autoregressive distributed lag (ARDL) was utilized and results suggest a significant and positive nexus between oil production and economic growth for both the sort-run and long-run span.

3.1 Data and Methodology

Data has been obtained from SAMA, annual report (2014) with estimated data for 2015. The study has covered the period 1970-2015 which fully involves most of oil price shocks including the recent decline in oil prices since mid-2014. In the lack of quarterly data, annual series were chosen to avoid the shortcomings of interpolation process. This study focuses on oil prices and economic activity of the Saudi economy. The variables used in this study are as follows:

GDP: Real Gross Domestic Product (millions of Saudi Riyals**).**

I: Real total investment (millions of Saudi Riyals).

GE: Real total government expenditures (millions of Saudi Riyals).

TB: Real total trade balance (millions of Saudi Riyals).

CPI: Saudi consumer price index.

ROP: Real Brent crude oil prices (US dollars). All variables are taken in logarithm and deflated by Saudi CPI. μ: The error term.

3.2 Unit Root Analysis

We used E-views program to test stationarity of variables to guarantee its non-stationarity in order to examine the long-run equilibrium. Generally, the augmented dickey- fuller test was conducted to check whether a particular variable is stationary or not with relaxing the assumption that the error term is uncorrelated as follows:

$$\Delta Y_t = \beta_1 + \beta_2 \Delta Y_{t-1} + {}^{\delta}Y_{t-1} + \mu \qquad \text{(With constant)}$$

$$\Delta Y_t = \beta_1 + \beta_2 t + \beta_3 \Delta Y_{t-1} + {}^{\delta}Y_{t-1} + \mu \qquad \text{(With constant and Trend)}$$

In addition, we used Phillips-Perron (PP) test (1988) as alternative test controlling for serial correlation and heteroscedasticity. As can be seen in Table 1, we found all variables are non-stationary at level, but stationary at first difference indicating that Y_t is integrated of order 1 (Y_t~I (1)).

Table 1. Results of unit roots tests

	ADF		PP		Order of integration
	Level	1st difference	Level	1st difference	
LGDP	-3.026	-6.181***	-3.007	-6.178***	I(1)
LGE	-3.065	-4.894***	-3.015	-4.876***	I(1)
LI	-1.991	-10.521***	-2.911	-10.085***	I(1)
LTB	-2.027	-5.622***	-2.231	-5.622	I(1)
LROP	-2.077	-7.376***	-2.077	-7.582	I(1)

Note. ** denotes significance at 5% and *** denotes significance at1%.

3.3 Johansen – Juselius Multivariate Cointegration Test

After founding variables non stationary, we should check for the long run nexus between variables. This process is determined via two steps; the first one based on trace statistic and the second is based on the maximum eigenvalue statistic. Prior to the above, the optimal lag order for VAR model must be determined. Based on akaike information criterion (AIC), we choose lag (Note 2).

Table 2. Unrestricted cointegration rank test (trace)

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.715330	129.0532	69.81889	0.0000
At most 1 *	0.523733	75.02689	47.85613	0.0000
At most 2 *	0.435742	43.13053	29.79707	0.0008
At most 3 *	0.241691	18.52403	15.49471	0.0169
At most 4	0.142837	6.627461	3.841466	0.0100

Trace test indicates 5 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table 3. Johansen- juselius cointegration test results based on maximum eigenvalue statistic

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.715330	54.02632	33.87687	0.0001
At most 1 *	0.523733	31.89636	27.58434	0.0131
At most 2 *	0.435742	24.60649	21.13162	0.0155
At most 3	0.241691	11.89657	14.26460	0.1146
At most 4	0.142837	6.627461	3.841466	0.0100

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level.

* Denotes rejection of the hypothesis at the 0.05 level.

**MacKinnon-Haug-Michelis (1999) p-values.

3.4 Trace Statistics

The null Hypothesis we test here is that there are less than or equal to r cointegrating vectors and the alternative is the opposite, which is more or equal to as follows: H0: $r \leq 1$ and H1: $r \geq 2$. If the test statistic is greater than the critical value (i.e., probability is less than 5 %), then we reject Ho and accept H1. Hence, there is at least 3 cointegrating vectors.

3.5 Max Eigenvalue Statistics

It is similar to the trace statistics but specifically test whether r is equal to or not. We follow this procedure to determine how many cointegrating vectors are as follows: Ho: r =1 and H1: r =2. If the test statistic is greater than the critical value (i.e., probability is less than 5 %), then we reject Ho and accept H1. Table 3 illustrates that the statistics are greater than the critical value; thus, we reject the null Ho at 5% level of significance. Hence, two cointegrating vectors are found based on the max eigenvalue statistic.

3.6 Granger Causality Test

Table 4. Results of granger causality test

Pairwise Granger Causality Tests

Date: 03/03/16 Time: 16:34

Sample: 1970 2017

Lags: 3

Null Hypothesis:	Obs	F-Statistic	Prob.
LGE_A does not Granger Cause LGDP_A	43	1.76877	0.1706
LGDP_A does not Granger Cause LGE_A		5.46686	0.0034
LI_A does not Granger Cause LGDP_A	43	2.28428	0.0954
LGDP_A does not Granger Cause LI_A		2.15147	0.1108
LTB_A does not Granger Cause LGDP_A	43	1.09804	0.3625
LGDP_A does not Granger Cause LTB_A		0.07994	0.9705
LROP_A does not Granger Cause LGDP_A	43	0.35357	0.7868

LGDP_A does not Granger Cause LROP_A		0.12789	0.9429
LI_A does not Granger Cause LGE_A	43	4.68102	0.0073
LGE_A does not Granger Cause LI_A		3.68597	0.0206
LTB_A does not Granger Cause LGE_A	43	3.13511	0.0373
LGE_A does not Granger Cause LTB_A		0.77089	0.5179
LROP_A does not Granger Cause LGE_A	43	0.87353	0.4638
LGE_A does not Granger Cause LROP_A		0.33378	0.8010
LTB_A does not Granger Cause LI_A	43	6.64553	0.0011
LI_A does not Granger Cause LTB_A		0.05766	0.9815
LROP_A does not Granger Cause LI_A	43	0.00737	0.9991
LI_A does not Granger Cause LROP_A		0.02392	0.9949
LROP_A does not Granger Cause LTB_A	43	1.50800	0.2290
LTB_A does not Granger Cause LROP_A		0.47663	0.7005

Pair wise Granger Causality test are performed and presented in table 4. Oil price does not affect the GDP in the short run based on Grange causality test. However, a positive long-run nexus between oil prices and economic growth exists referring to the error correction model's results. In addition, real GDP is impacting the government spending. Definitely, a country as Saudi Arabia with huge output would require higher government spending to assure sustainability of growth. Table 5 also shows that real investment is affecting the output as expected. Higher investment would trigger economic activity through higher demand. Finally, real trade balance is found to be moving real investment at the Saudi economy.

3.7 Vector Error Correction Model (VECM)

The results of the VECM estimates are presented in Table 6. The first part provides the long run relationships among cointegrated variables. The long run relationship (i.e., the equilibrium) between variables are as follows:

$$Log\ GDP_t = 6.33 + 0.39\ Log\ I_t + 0.13\ Log\ GE_t + 0.03\ Log\ TB_t + 0.09\ Log\ ROP_t + \mu$$

The above Cointegration equation is representing the nexus between Saudi's GDP and other macroeconomic factors under study in the long- run span. Coefficients are positive and significant as expected theoretically. The coefficient of oil price displays a positive impact on GDP as an increase of 1% at the oil price, would lead to an increase in the Saudi's real GDP by 0.09%. Thus, this is consistent with the expected assumption about how oil prices apparently can affect the Saudi's economy in general, and specifically on the GDP. Furthermore, the government expenditures has positive effects on the GDP. If government expenditures are raised by 1%, GDP will grow by 0.13%, indicating a crucial importance of fiscal policy for the Saudi economy. This finding is consistent with findings in Alghaith et al. (2014) and Algahtani et al. (2015). Moreover, a 1% rise in trade balance surges the GDP by 0.03%.

The next part of VECM results in table 6 captures how disequilibrium among cointegrated variables is corrected each year by the error correction term (ECT). The coefficients of ECTs are statistically significant at 5% confirming the existence of equilibrium in the model. About 92.8% of disequilibrium in GDP is corrected each year. This means that the real GDP converges to the long run equilibrium value after the shocks on the oil prices, investment, government expenditures and trade balance. In the same vein, 97.9% and 208.2% of disequilibrium in government expenditures and trade balance respectively are corrected each year. Similarly, about 42% of disequilibrium is corrected in investment each year.

Table 2. Results of vector error correction model

Vector Error Correction Estimates
Date: 03/03/16 Time: 16:19
Sample (adjusted): 1973 2015
Included observations: 43 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LGDP_A(-1)	1.000000
LI_A(-1)	-0.390877
	(0.07609)
	[-5.13706]

LGE_A(-1)	-0.131242				
	(0.05161)				
	[-2.54284]				
LTB_A(-1)	-0.032004				
	(0.01604)				
	[-1.99566]				
LROP_A(-1)	-0.096685				
	(0.03352)				
	[-2.88414]				
C	-6.339240				
Error Correction:	D(LGDP_A)	D(LI_A)	D(LGE_A)	D(LTB_A)	D(LROP_A)
CointEq1	-0.928868	0.420077	-0.979501	-2.082113	-0.752960
	(0.41614)	(0.65169)	(0.41586)	(1.70314)	(0.81333)
	[-2.23210]	[0.64459]	[-2.35536]	[-1.22252]	[-0.92577]
D(LGDP_A(-1))	1.061152	0.954409	1.188225	3.535366	1.020161
	(0.42218)	(0.66115)	(0.42190)	(1.72786)	(0.82514)
	[2.51349]	[1.44355]	[2.81637]	[2.04609]	[1.23634]
D(LGDP_A(-2))	0.239662	-0.416981	0.520357	0.128637	0.526929
	(0.48398)	(0.75793)	(0.48365)	(1.98078)	(0.94592)
	[0.49519]	[-0.55016]	[1.07589]	[0.06494]	[0.55705]
D(LI_A(-1))	-0.564195	-0.928637	-0.184388	-0.843827	-0.303662
	(0.18220)	(0.28534)	(0.18208)	(0.74571)	(0.35611)
	[-3.09649]	[-3.25450]	[-1.01266]	[-1.13158]	[-0.85271]
D(LI_A(-2))	-0.146408	0.081062	-0.066097	0.065234	-0.119638
	(0.17868)	(0.27982)	(0.17856)	(0.73128)	(0.34922)
	[-0.81939]	[0.28970]	[-0.37017]	[0.08921]	[-0.34259]
D(LGE_A(-1))	0.150027	0.915638	-0.119947	-0.523326	0.052027
	(0.21663)	(0.33926)	(0.21649)	(0.88662)	(0.42340)
	[0.69253]	[2.69895]	[-0.55406]	[-0.59025]	[0.12288]
D(LGE_A(-2))	-0.141929	0.395418	-0.325321	-1.110859	-0.508877
	(0.20900)	(0.32730)	(0.20886)	(0.85536)	(0.40848)
	[-0.67910]	[1.20813]	[-1.55763]	[-1.29870]	[-1.24579]
D(LTB_A(-1))	-0.091408	-0.218902	-0.057430	0.019985	-0.205121
	(0.09593)	(0.15023)	(0.09587)	(0.39262)	(0.18749)
	[-0.95285]	[-1.45709]	[-0.59906]	[0.05090]	[-1.09401]
D(LTB_A(-2))	0.107377	0.259730	0.072906	0.278885	0.119168
	(0.08533)	(0.13364)	(0.08528)	(0.34925)	(0.16678)
	[1.25831]	[1.94355]	[0.85493]	[0.79853]	[0.71451]
D(LROP_A(-1))	-0.101096	-0.136137	-0.148801	-1.385918	-0.170884
	(0.19049)	(0.29831)	(0.19036)	(0.77961)	(0.37230)
	[-0.53072]	[-0.45636]	[-0.78169]	[-1.77771]	[-0.45899]
D(LROP_A(-2))	-0.314501	-0.712816	-0.151667	-0.602546	-0.438301
	(0.19241)	(0.30133)	(0.19228)	(0.78749)	(0.37607)
	[-1.63451]	[-2.36559]	[-0.78877]	[-0.76515]	[-1.16549]
C	-0.552499	0.143608	-0.562109	-1.367056	-0.568554
	(0.27055)	(0.42370)	(0.27037)	(1.10730)	(0.52879)
	[-2.04210]	[0.33894]	[-2.07901]	[-1.23459]	[-1.07520]
T	0.023023	-0.006025	0.022659	0.051772	0.020895
	(0.01049)	(0.01643)	(0.01049)	(0.04295)	(0.02051)
	[2.19400]	[-0.36661]	[2.16081]	[1.20547]	[1.01879]
R-squared	0.408204	0.552974	0.442877	0.260200	0.147920
Adj. R-squared	0.171485	0.374164	0.220027	-0.035720	-0.192912
Sum sq. resids	0.872835	2.140600	0.871661	14.62008	3.334181
S.E. equation	0.170571	0.267120	0.170456	0.698095	0.333376
F-statistic	1.724428	3.092518	1.987337	0.879291	0.433997
Log likelihood	22.77564	3.488093	22.80457	-37.82006	-6.039434

Akaike AIC	-0.454681	0.442414	-0.456027	2.363724	0.885555
Schwarz SC	0.077775	0.974870	0.076429	2.896180	1.418011
Mean dependent	0.063668	0.074885	0.074151	0.012839	-0.009911
S.D. dependent	0.187394	0.337658	0.193007	0.685951	0.305232
Determinant resid covariance (dof adj.)		2.57E-08			
Determinant resid covariance		4.25E-09			
Log likelihood		109.3835			
Akaike information criterion		-1.831790			
Schwarz criterion		1.035280			

3.8 Vector Autoregressive Results

In addition to the VECM model, impulse response functions (IRFs) were obtained in order to assess the short-run dynamics of the model. Based on related literature, we have assumed the following ordering: real oil prices, real government expenditures, real investment, real trade balance and real GDP.

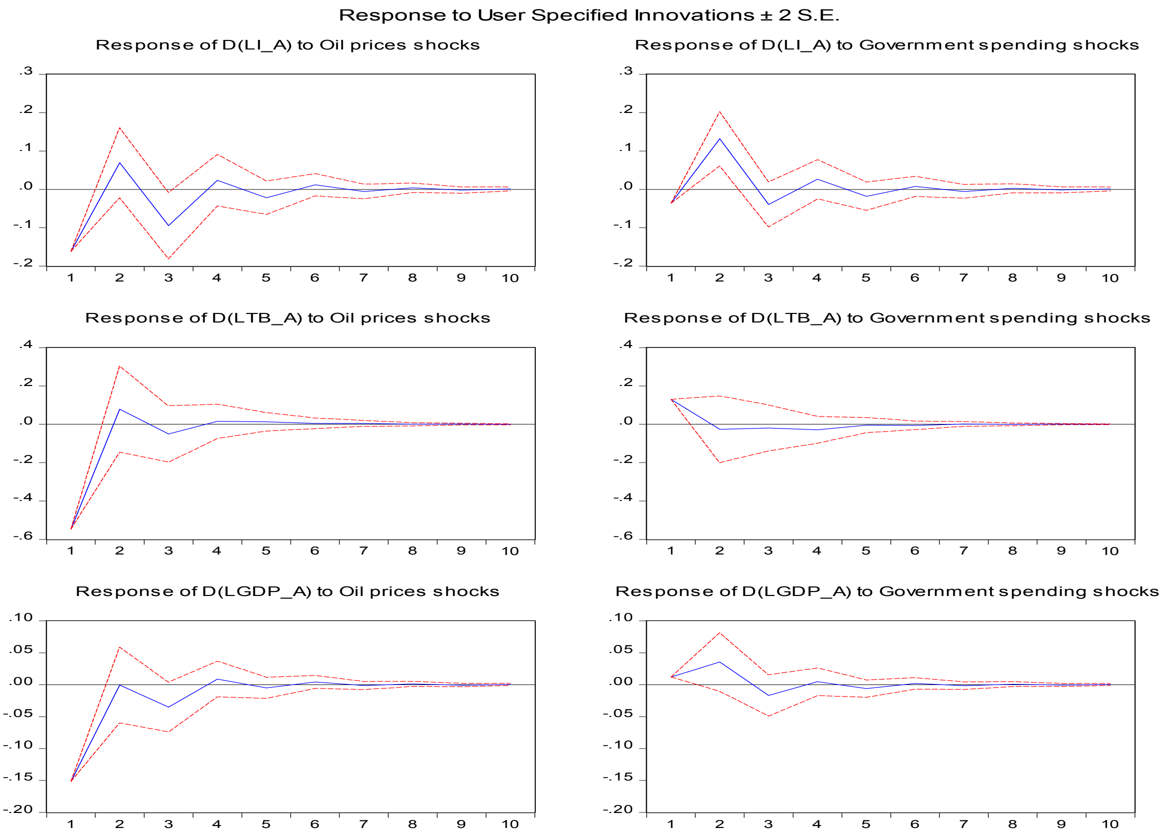

Figure 3. Impulse response functions

As expected for an economy heavily relied on oil as Saudi Arabia, oil prices have a significant and sustained impact on real investment, real trade balance and real GDP as well (Figure 3). A one standard deviation negative shock to oil prices (equivalent to a 32 percent drop in oil prices) reduces real investment, real trade balance and real GDP in the first year and then dies out (Note 3). Similarly, a one standard deviation positive shock to government expenditures, surges real investment, real trade balance and real GDP. The above findings are consistent with results in Alghaith et al. (2014) and Algahtani et al. (2015).

4. Conclusion

In most of GCC countries, GDP is substantially affected by the oil revenue driven by oil price trends. Indeed, oil plays a key role in economies with high dependence on oil receipts. The oil revenue of Saudi's GDP is accounted of high amounts and it is the main driver for economic activity. This study applied the VAR and VECM models to examine the long-run and short-run relationships between oil prices, government expenditure, investment, trade balance and GDP during the period 1970-2015. The cointegration results suggest a long-run significant and positive relationship between oil prices and GDP. In addition, there was a long run relationship between government expenditures, trade balances and GDP which is consistent with literature for an oil- exporting country as Saudi Arabia.

Saudi Arabia, in particular, should focus more on petroleum and oil aspects with effective production as the oil is the main resource of revenues. It should use surpluses prudentially on enhancing the private sector, promoting the industrial constructions and diversifying the economy to reduce relying on oil.

This study comes in somewhat economic revolution in Saudi Arabia as a National Transformation Program (NTP) among other programs will be announced around April 2016 (Note 4). Saudi Arabia is conducting many economic reforms to reduce its reliance on oil through the NTP with other plans and projects. The NTP is likely to provide a roadmap for major social and economic initiatives for the next five years to diversify the economy. It is expected to raise non-oil revenue by $100 billion by 2020. In addition to the above economic reforms, the Public Investment Fund (PIF) is planned to be restructured becoming the world's largest sovereign wealth fund with assets more than $2 trillion.

More research should be focusing on effect of petroleum industry on the Saudi economies and reliable resources should be initiated by promoting education and technology along with high quality of training and stable investments of surpluses. The nexus between financial markets activities and oil prices in the Saudi economy can be studied measuring how to contribute to the economic activity.

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Notes

Note 1. The 2016 budget was released by Ministry of Finance.

Note 2. Among econometricians, the optimal lag of VAR model for annual data, quarterly data is 1-2 and 4 respectively.

Note 3. When IRFs dies out, it indicates that the system is stable.

Note 4. The Bloomberg interview with Deputy Crown Prince Muhammad Bin Salman took place in Riyadh on 1st of April, 2016.