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The Effects of Asymmetric Oil Price Shocks on the Saudi Consumption: An Empirical Investigation

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ABSTRACT

The purpose of this paper is to analyze theoretically and empirically the relationship between the asymmetric oil price shock and the consumption in Saudi Arabia for the period 1985-2015. This paper follows Mehra and Petersen (2005), Zhang and Broadstock (2014), and has added a new perspective through which the oil price shocks are transmitted to consumption in the Saudi economy. The oil price shock is calculated, as scale oil price increase, using generalized autoregressive conditional heteroskedasticity (1,1). Vector autoregression and vector error correction models are applied, and the findings confirm that the oil price shocks affect positively (+) the earnings of oil, and thereby total consumption. An increase in oil price will cause an increase in revenues, and hence consumption and vice versa. However, the decline in oil revenue on average is about (−21) percent, whereas the fall in consumption is about (−24) percent. These results coincide with the causality tests. Although, Mehra and Petersen (2005) found negative impacts of oil price shocks, our results differ in sign because this work is concerning an oil-exporting country.

Keywords: Consumption, Saudi Arabia, Asymmetric Shocks, Generalized Autoregressive Conditional Heteroskedasticity
JEL Classifications: C5, E21

1. INTRODUCTION

The oil price slump since the middle of 2014, is considered one of the sharpest fall in the price of the crude oil since the financial crisis in 2008. In part is due to the world oil glut which is created by the need of countries for more financial resources. On the contrary, shrinking demand and glut in the oil market caused prices of oil to crash. As a major oil producer, the fall in oil price would cause revenues to shrink, which in turn lower income and then consumption demand expenditure. As a departure point of scattered studies, it is of interest to discuss and test empirically for the relationship between oil price shocks and consumption and deduce the consequences and their implications. Nonetheless, the oil price shocks in 1970s and in the 1980s ignited efforts of scholars to study extensively the impacts of such shocks on the macroeconomics variables such as economic growth, inflation and the rest of relevant macroeconomic variables.

Although oil prices variations and their effects on macroeconomic variables present in the literature, the emphasis on the consumption expenditure is concentrated in a handful studies. The scarcity of researches and their applications covering this topic forwarded my enthusiasm to explore it. The relationship between oil price shocks and growth had a great attention in the literature. It started with Hamilton (1983), where he studied the broad relationship between oil price shocks and recession in the United States. Mork (1989) elaborated on Hamilton's work and the legend continued till present. Researchers turned their attention to the study the correlation between oil price shocks and economic growth and the financial sector (Kilian, 2007). Some scholars are not yet convinced that is the step-in recession in 1970s in the US is caused by oil price shocks (Arora et al., 2013). There are reasons that prevent such an oil price shocks of occurrence nowadays. Labor unions are not stronger as before, and the use of monetary policy to dampen any negative effects of the oil price shocks on the economy. There are some factors, but not all, that affect the oil prices. First, consumption of oil in china as an emerging giant country. Secondly, large consumption of oil in worldwide economies. Thirdly, the American production of oil shale. Fourth, the demand on oil worldwide which depends on elasticity of demand. Fifth, OPEC excess supply of oil which created a glut in the oil market, and finally, political turbulences and their impacts on the oil market in general.

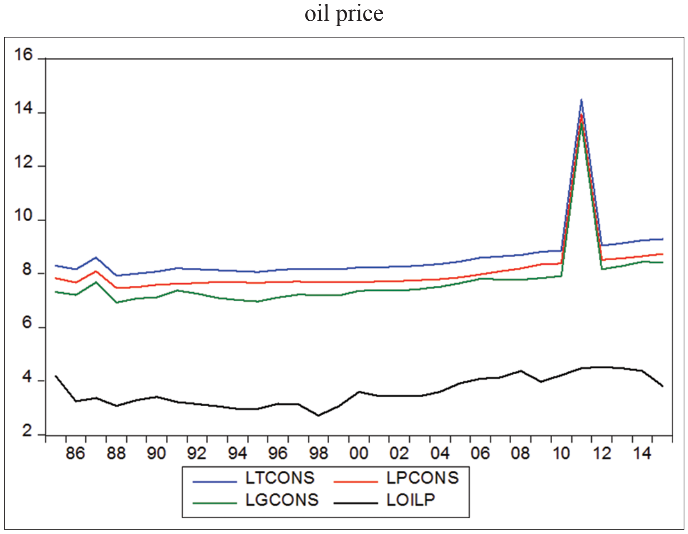
Consumption is an important element of aggregate demand and crucial for economic growth and cyclical fluctuations. Based on growth theory, society redistribute consumption between current consumption and future consumption (saving). However, future consumption is more volatile and not limited by changes in consumption only. "Random walk" theory of consumption, that is developed by Hall (1978), and used by many of researchers, assumes that the change in consumption is large enough to be unpredictable.

Going back to data which is represented in Figure 1, real oil prices (OPEC basket) has risen from \$11.67 in the year 1970 to reach \$45.26 in 1974. Nonetheless, the oil prices reached another peak with \$76.09 in the year 1982. It fluctuated in market values in a noticeable manner. In 2012, peaked again with \$92.40 per a barrel. From that date, the decline journey of prices continued until prices eventually stabilized at the price of upper \$40s nowadays. The fluctuations in prices accompanied with variations on some, if not all, of the macro economic variables in oil-exporting countries. The government earnings, and hence government consumption expenditure followed the volatility of oil prices. Private consumption expenditure in year 2015 almost 125 times the private consumption expenditure in 1970. However, the speed of consumption is increasing at lower levels. The decline in oil price since 2015 restraint the speed of consumption expenditure. Similarly, the government consumption expenditure has increased in 2015 by about 186 folds 1970's governmental consumption expenditure. The total consumption expenditures are fluctuated sharply, since the total consumption expenditure is the sum of private consumption expenditure and government consumption expenditures.

Figure 1 shows the role of the oil revenues and their effects on the Saudi economy. The main point here is that, the volatility of oil prices reflected in the form of fluctuations in the oil revenues and hence, on the consumption expenditure variable, private and government.

The scope of this paper different from other studies done on Saudi Arabia in two-folds. First, the methodology, where the concentration is on the effects of oil price shocks namely, asymmetric oil price shocks. Secondly, a handful of studies covering the effects of oil prices on consumption expenditures in oil-importing economies. Not much studies available discussing this issue concerning oil-exporting countries, especially Saudi Arabia.

Figure 1: Real growth in government, private, total consumption and oil price



Although this paper does not consider the data from 1970s, it employed 1980's data. However, the use of data regarding fluctuations of oil prices in the 1980s is warranted. According to Gounder and Bartleet (2007), numerous researchers suggest that, the factor of cost share of the oil is low to cause a reduction in the US output growth after 1973/74 oil price shock. It could be attributed to the co-incidence due to the end of pegged exchange rate, which caused a major reduction in the US money supply. Thus, choosing the data covering 1985-2015 tends to be applicable and accepted.

The purpose of this paper is to investigate and test empirically, using the unrestricted vector autoregression (VAR) approach, the effects of asymmetric oil prices shocks (OIL^{shock}) on real total consumption expenditure, real government revenues, and real lagged total consumption. This paper follows Mehra and Petersen (2005), and Zhang and Broadstock (2014). The aim is to identify the channels through which the oil price shocks transmitted into the consumption expenditures, and conclude empirically whether the asymmetric oil price shocks in a major member of OPEC has influenced consumptions.

This paper is organized as follows: Section 1 an introduction. Section 2 reviews the theoretical and empirical literature. Section 3 develops the theoretical model, estimation and discussions of the empirical results and their implications, and Section 4 presents a summary of the results and policy suggestions.

2. REVIEW OF LITERATURE AND EMPIRICAL STUDIES

Keynesian theory of consumption asserts that current disposable income is the key factor in consumption expenditure, which is no longer stands firm, given theoretical and long-run empirical justifications and findings. Permanent income hypothesis (PIH), by Friedman asserted that households' consumption is proportional to his/her permanent income that is the average income which one expects to get over time. However, income other than current income affects pattern of consumption. Moreover, this theory explains both long-run average propensity to consume and its variations during income fluctuations. Thus, it explains aspects of consumer behavior with long-run variations in his/her permanent income, which reflects aggregate income growth (Bayar and McMorrow, 1999). On the policy front, it helps to explain the economic impact of small cut and its effects relative to permanent cut.

Modigliani's life cycle hypothesis is like PIH built on the premise that consumption is a proportion of person's life cycle. It explains the cycles with younger generation with low income who maintains consumption by either borrow or dis-save, whereas with income is high, saving is high to finance life after retirement. There are three factors that determine personal decision either to consume or save, that means current or future income. These are planning horizon, time preference and realization of his/her specific consumption path that is utility maximization (Bayar and McMorrow, 1999). Nonetheless, interest rates inclusion in the consumption function is warranted. Discounting future income requires the present of interest rates, and its importance as a variable in the intertemporal substitution effects. Away from the effects of variations of oil price on economic growth, attention recently has been drawn on the relationship between the variations in oil price and the consumption expenditure.

Meghir (2002) expressed his gratitude to the work, consumption function, done by Friedman. Friedman demonstrated that interaction between theoretical ideas and data analysis leads to policy implications. He presented a short review of PIH which constitutes of ideas and theoretical foundations. He elaborated on its influential role in modern economic theory. Finally, he discussed some empirical results and their origins in Friedman's literature.

Mehra and Petersen (2005) used empirical strategy to trace the net oil price increase on consumer spending. They applied life-cycle aggregate consumption used in Mehra (2001). Their work considers income and wealth as the determinant variables of the consumption expenditure. Regarding this case, life-cycle becomes more logical and one could estimate the elasticities of income and wealth. They concluded empirically that net oil price increases have a negative effect on consumer spending whereas oil price declines do not. Furthermore, oil price increases after stable periods of time matter more than oil price increases after sequential declines.

Segal (2007) surveys literature on the relationships between oil price changes and the macroeconomic variables. The purpose is to clarify that the development over all the world economy is not influenced by changes in the oil prices over the last 3 years, 2003-2007. His arguments are as follow. First, oil prices have been popular as thought of. Second, the channel through which oil prices affect the economy is monetary policy. Oil price causes inflation, then monetary authority raises interest rates, causing a slowdown in growth. Third, high oil prices have not reduced growth in the past 3 years because no effect of high oil prices on inflation. So, monetary authority tightening in response to oil price increase.

DePratto et al. (2009) estimated the New-Keynesian general equilibrium open economy model to test how changes in oil prices affect the macroeconomic variables. The model gives a chance to oil price changes through affecting the output gap. Canada, the US, and the UK are being tested for the period of 1971-2008. They concluded that oil prices affect the economy through supply side. Also, found that oil prices affect output gap and trend growth negatively. Finally, for the US, supply shocks have prolonged negative impact on trend growth.

Wang (2013) implements a logistic smoothing transition model to examine the impacts of oil prices increase on personal consumption expenditures in both open and industrialized economies. The empirical findings support that a nonlinear and asymmetric relationship between oil price variations and personal consumption expenditures exist. The rising prices of oil have greater effects than the falling prices. However, the oil price effects on personal consumption expenditures are transmitted via the real balance effects. Below a threshold value, an increase in oil prices reduce personal consumption expenditures. However, under uncertainty conditions, consumers may delay their spending on goods and services. Moreover, if oil prices above the threshold after a prolonged upward trend, prices of domestic production rise. Finally, the effect of rising oil prices varies from country to country depending on economic development and structures. Hence, personal consumption expenditures are different due to cross country pattern.

Gao et al. (2014) evaluate the oil price shock using disaggregated consumer price indexes (CPIs) in the US. Their analysis concentrated on the degree of pass-through of the oil price shocks. They found asymmetric positive effects of oil prices shock on energy-intensive CPIs. This indicates that the effects are transmitted through increase in prices of energy related commodities. The unexpected oil price decline cause a decrease in budget devoted for non-energy commodities, if the demand for energy is inelastic. The decrease in energy demand for non-energy commodities could cause some limited transmitted effects on non-energy commodities.

Zhang and Broadstock (2014) analyzed the impact of oil price shocks on consumption expenditure in selected ASEAN and East Asia countries. Incorporating the oil price shocks into the consumption function, the oil price shocks played a role in affecting consumption expenditure. Findings show that oil price shocks do influence consumption and there exists asymmetrical effects. They concluded that there are differences in the level and direction of the impacts on each country of the groups. They asserted that integration among the countries is needed, while each country plays its role.

Altai (2015) uses VAR model to examine the effects of oil prices on household final consumption expenditure in Sweden. Because of the oil price slump and the government's plan to reduce the dependence on oil consumption, he interested in seeing the effects. The findings support the significant reduction in oil consumption. Hence, the impact of oil price consumption is higher before 1990.

Vrontisi et al. (2015) presented a report describes the importance of oil and analyses the potential economic effects of low oil prices since mid-2014 on European Union (EU) economy. It assesses the impact of low oil prices up to 2020 and its effect on global oil consumption. It showed that a decline of oil prices from \$100 to \$50 leads to a gross domestic product gain of 0.7% both on global and EU28 level because of private consumption and investment. Hence, net oil-importing countries gain and net oil-exporting countries lose. They concluded that a drop of oil prices by 50% cause a generation of 3 million additional jobs. Moreover, oil-intensive sectors do not improve their competitiveness in comparison with other regions of EU. Thus, less energy efficient and benefit more from the low oil prices.

Zaman (2015) addressed the effects of oil price shocks on consumer spending in the short and long-run in five OECD countries, Canada, the US, Germany, the UK, and Sweden. She tested using VAR methodology. She found a significant short-run impact on consumption spending. The test used oil price changes and net oil price increase. The results are strongly significant for Canada and the US. It is inconclusive in the case of the rest of the OECD countries under study. The economic findings support the fact that oil prices have influence on consumption decisions over importing and exporting oil countries.

Lacoviello (2016) studies the impacts of oil prices on consumption across countries and the US states. He used newly quarterly dataset for 50 countries for the period of 1975-2015. He showed that the price decline had positive and strong effects on consumption of oil-importing countries, whereas affecting negatively the oil exporting countries. He also showed the effects of the decline of oil prices over the US states depending on the reliance of each state on oil consumption.

3. THE MODEL, ESTIMATION, AND DISCUSSION

PIH is built on the premise that, person's intuition to smooth consumption without making it fluctuates as short-run variations in income. The analysis here relies on the adoption of Romer (2012), Mehra and Petersen (2005), and Zhang and Broadstock (2014). The investigation will consider the effects on consumption expenditure as a response to asymmetric oil price shocks. According to Mehra (2001), income and wealth are the major determinants of consumer spending. Moreover, life-cycle aggregate consumption equations provide good estimates of elasticities of wealth and income, besides explaining the short-term behavior of consumer spending and consumer behavior.

Consider a person who lives for T period of time, and he/she's life time utility function is:

$$U = \sum_{t=1}^{T} u(C_t) \tag{1}$$

$u'(\bullet) > 0$, $u''(\bullet) < 0$

Where:
$u(\bullet)$ is instantaneous utility function,
C_t is consumption in period t.

The person's wealth W_0 and labor income $Y_1, Y_2,\ldots, Y_T$, and he/she can borrow or save at exogenous interest rate which is assumed to be zero. The budget constraint is:

$$\sum_{t=1}^{T} C_t \leq W_t + \sum_{t=1}^{T} Y_t \tag{2}$$

Given marginal utility of consumption is positive, he/she will satisfy the budget constraint with equality. The maximization problem becomes:

$$£ = \sum_{t=1}^{T} u(C_t) + \lambda\left(W_t + \sum_{t=1}^{T} Y_t - \sum_{t=1}^{T} C_t\right) \tag{3}$$

The first order condition for C_t is:

$$u'(C_t) = \lambda \tag{4}$$

Given Equation (4), marginal utility of consumption is constant and hence, consumption is constant such that: $C_1 = C_2 = \ldots\ldots = C_t$.

Given the analysis above, the level of consumption C_t is affected by current income Y_t and wealth W_t and expected income as $E(Y_{t+1})$, where $t = 1, 2.,\ldots,\infty$. The budget constraint is:

$$W_{t+1} = (1+r_t)(W_t + Y_t - C_t) \tag{5}$$

This means that, next period wealth is equal to the discounted wealth and earned income minus consumption expenditure. With the assumption of constant interest rate such that: $r = r_1 = r_{t+1}$, in addition to $\lim_{i\to\infty}(W_t + i/(1+r)^i = 0$. Then by repeated substitution W_t becomes:

$$W_t = \sum_{i=0}^{\infty} \frac{C_t + i}{(1+r)i} - \sum_{i=0}^{\infty} \frac{Y_t + i}{(1+r)i} \tag{6}$$

Since consumption follows a marginal process then, $E(C_{t+1}) = C_t$. If we take expecion (6), we get PIH.

$$C_t = r/(1+r)\sum_{i=0}^{\infty} \frac{E(Y_t + i)}{(1+r)i} + r/(1+r)\ W_t \tag{7}$$

Thus, $E(Y_{t+1}) = (1+g)\ Y_t + \eta_{t+1}$, where η_{t+1} is a white noise process. The equation becomes:

$$C_t = r/(r-g)\ Y_t + r/(1+r)\ W_t + \sum_{i=1}^{\infty} \frac{\eta_{t+1}}{(1+r)i} \tag{8}$$

From Equation (8), there exists long run relationships between consumption, income and wealth. This is called C_t^P, the level of consumption, (Mehra, 2005), that is:

$$C_t^P = \pi_0 + \pi_1 Y_t + \pi_2 W_t \tag{9}$$

Where $\pi_1 = r/(r-g)$, and $\pi_2 = r/(1+r)$. Actual consumption is different from planned consumption. The short run dynamic consumption can be written as:

$$\Delta C_t = \lambda_0 + \lambda_1\left(C_{t-1}^P - C_{t-1}\right) + \lambda_2 \Delta\ C_{t-1}^P + \sum_{s=1}^{k} \lambda_3 s \Delta C_{t-s} + u_t \tag{10}$$

Substituting Equation (9) into Equation (10), yields:

$$\Delta C_t = \lambda_0 + \lambda_1(\pi_0 + \pi_1 Y_{t-1} + \pi_2 W_{t-1} - C_{t-1}) + \lambda_2 \Delta(\pi_0 + \pi_1 Y_{t-1} + \pi_2 W_{t-1}) + \sum_{s=1}^{k} \lambda_3 s \Delta C_{t-s} + u_t \tag{11}$$

If we assume that future income grows constantly relative to the current level, and consumers are rational, so the discounted future income is proportional to current income such that:

$$\Delta C_t = \delta_0 + \delta_1\left(C_{t-1}^P - C_{t-1}\right) + \delta_2 \Delta Y_{t-1} + \delta_3 \Delta W_{t-1} + \sum_{s=1}^{k} \delta_4 s \Delta\ C_{t-s} + u_t \tag{12}$$

Equation (12) captures the dynamics of consumption changes. The oil prices are augmented into the short run such as:

$$\Delta C_t = \delta_0 + \delta_1\left(C^P_{t-1} - C_{t-1}\right) + \delta_2 \Delta Y_{t-1} + \delta_3 \Delta W_{t-1} + \sum_{s=1}^{k} \delta_4 s \Delta C_{t-s} + \sum_{s=1}^{k} \delta_5 s \Delta OIL^{shock}_{t-s} + u_t \quad (13)$$

Equations (12) and (13) are the major focus of the empirical testing. The work here will specify the following function:

$$\Delta C_t = \alpha_0 + \alpha_1 OR_t + \alpha_2 C_{t-1} + \alpha_3 OIL^{shock} + e_t \quad (14)$$

$\alpha_1 > 0$, $\alpha_2 > 0$, and $\alpha_3 > 0$.

Where,
ΔC_t is real log total consumption (private and government),
OR_t is log real oil revenues,
C_{t-1} is real log total consumption (private and government) lagged one period,
OIL^{shock} is an oil price shock calculated using generalized autoregressive conditional heteroskedasticity (GARCH) (1,1), and e_t is error term.

3.1. Asymmetric Oil Price Shocks

Oil prices is characterized by high volatility over a long range. Lee et al. (1995), in Zahid et al. (2011), proposed generalized AR conditional heteroscedasticity, GARCH (1,1) to capture the effect of oil prices, such that:

$$DOP_t = \zeta_0 + \zeta_1 DOP_{t-1} + U_t \text{ (mean equation)} \quad (15a)$$

$$U_t \sim N(0, \delta^2)$$

$$h_t = \lambda_0 + \lambda_1 U^2_{t-1} + \beta h_{t-1} \text{ (variance equation)} \quad (15b)$$

Where, U_t is the white noise. The mean equation is a function of constant and a regressor plus error term. However, the variance equation is written to include constant, ARCH term that captures pervious year volatility. λ_1 and β are positive to guarantee that h_t is positive. So, $\delta_0 + \beta < 1$ to ensure that h_t is stationary.

Since the decrease and increase oil price shocks have been used for Saudi Arabia (Algaeed, 2016), it is plausible to use SOPI - the scale oil price increase, sometimes refer to it as a shock variable (Figure 2). In order to implement the scale variable, AR (1) is estimate using ordinary least square (OLS). Arch effect is tested and found no Arch effect (P = 0.0031), thus the null hypothesis of existence of ARCH effect is rejected. This result implies a green light for using the GARCH.

3.2. Unit Root Test

The first step in our analysis is to determine the unit root. Variable is said to be integrated of order n, I(n) if it necessitates differencing times n to attain stationarity. However, three regression models are used in the literature incorporate intercept, intercept and trend, and none. All three are used in this paper to test for unit roots. Augmented Dickey–Fuller (ADF) and Phillips–Peron (PP) tests are employed to examine the stationarity of the time series. ADF test is performed using the following equation:

$$\Delta Y_t = \varphi + \eta T + \delta \Delta Y_{t-1} + \beta i \sum_{i=1}^{n} \Delta Y_{t-i} + \varepsilon_t \quad (16)$$

Where, is φ a constant, η is the coefficient of time trend T, δ and β are the parameters where, $\delta = \rho - 1$, ΔY is the first difference of Y series, n is the number of lagged first differenced term, and ε_t is the error term. The PP test is performed using the following equation:

$$\Delta Y_t = \psi + \zeta T + \lambda \Delta Y_{t-1} + \varepsilon_t \quad (17)$$

Where, ψ is a constant, ζ is the coefficient of time trend T, λ is the parameter and ε_t is the error term. To achieve this task, ADF (1987), and PP (1990) tests are applied. Results for these tests are similar and close to each other, and thus, reported in Table 1. Both tests showed that variables are stationary at the difference in the ADF and PP tests. Some of the variables, such as consumption and shock variables, are not stationary at level I(0). Moreover, all variables are stationary at difference I(1) and significant at 1% and 5% level. However, to obtain short and long-run analyses, it is of interest to have all relevant variables in the same order, I(1).

3.3. Johansen Co-integration Test Result

The importance of long-run equilibrium and stationarity is to eliminate the presence of spurious regression. Johansen's co-integration test requires deciding the lag length which can be calculated through unrestricted VAR models. From Table 2, trace statistic test confirms the existence of 1 co-integrated equations at the 5% level. The null hypothesis for the trace test is that, there is no co-integration between real oil price shocks, OIL^{shock}, real oil revenues, OR_t, and consumption expenditure C_t. So, the null hypothesis of None is rejected, indicating that there is at most one co-integrated equation. Furthermore, Max-eigen test indicates 1 co-integration equations. The null hypothesis of max-eigen test is rejected, which implies that there is at most one co-integration between OIL^{shock}, OR_t, and C_t. Similarly, Table 2 reveals the existence of at most 1 co-integration test by both trace and max.

3.4. Causality Tests

In the literature, Jalil et al. (2009), the standard Granger causality test in bivariate environment specified as followed:

Figure 2: Residual of Equation (15a)

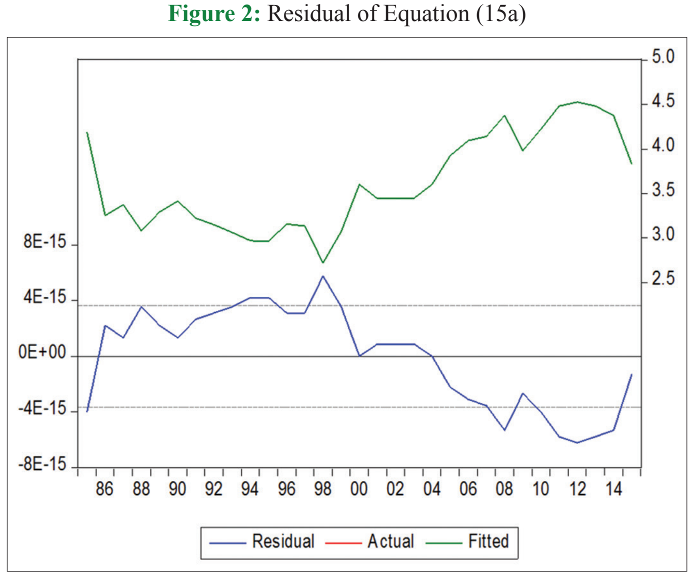


Table 1: ADF and PP tests

Series	ADF						PP					
	Level			1st difference			Level			1st difference		
	Intercept	T&I	None	Intercept	T&I	None	Intercept	T&I	None	Intercept	T&I	None
Shock	1.69	3.99**	1.73***	6.51*	6.08*	6.59*	1.76	3.98**	1.79**	6.67*	6.18*	6.57*
Consumption	4.53*	4.44*	0.023	2.90**	3.18***	3.33**	4.29*	5.27*	0.11	27.14*	27.51*	20.98*
Oil revenues	0.85	3.65**	1.33	6.21*	5.09*	6.15*	0.74	3.59**	1.11	7.12*	8.30*	6.32*

*,**, and *** are statistically significant at 1%, 5% and 10% level respectively. T&I: Trend and intercept, ADF: Augmented Dickey–Fuller, PP: Phillips Perron

Table 2: Johansen co-integration test result

Hypothesized number of CE (s)	Trace statistic	0.05 critical statistics	Hypothesized number of CE (s)	Max-Eigen statistic	0.05 critical statistic
None*	32.0950**	29.7971	None*	21.4402**	21.1316
At most 1	10.6548	15.4947	At most 1	9.5944	14.2646
At most 2	1.06032	3.8415	At most 2	1.06032	3.8415

Trace test indicates 1 co-integration, and Max test 1 co-integration equations. *Rejection of the hypothesis at the 0.05 level. **Mackinnon-Haug-Michelis (1999) P values

$$\Delta Y_t = \eta + \sum_{i=1}^{p} \eta Y_i \Delta Y_{t-i} + \sum_{i=1}^{p} \eta X_i \Delta X_{t-i} + e_t \quad (18a)$$

Where, Δ is first difference operator and ΔX, ΔY are stationary time series. If the coefficients ηX_i are jointly significant, the null hypothesis that x does not Granger cause Y is rejected. This causality captures the short-run effects. However, if there is a cointegration relationship between two variables, there exists causality among the variables. The causality direction is clearly seen in using vector error correction model (VECM), such that:

$$\Delta Y_t = \eta + \sum_{i=1}^{p} \eta Y_i \Delta Y_{t-i} + \sum_{i=1}^{p} \eta X_i \Delta X_{t-i} + \beta E y_{t-1} + e_t \quad (18b)$$

Where, ΔX and ΔY are first difference stationary and cointegrated variables. Ey_{t-1} is lagged value of error correction term (ECT), where,

$$Ey_{t-1} = Y_t - v X_t \quad (18c)$$

If the coefficient ηX_i are jointly significant and β is significant too, then the null hypothesis that ΔX does not Granger cause ΔY is rejected. Tables 3 and 4 reveal the causality tests. VAR and VECM causality tests showed that causality is running from oil price shock, OIL^{shock}, to government revenues then to consumption expenditures. On the other hand, pairwise causality test indicates clearly the rejection of the null hypotheses that shock does not Granger cause oil revenues and consumption expenditures. Hence, causality is running from oil price shocks to oil revenues and consumption expenditures.

3.5. Asymmetric Oil Shock Result

Applying Equations (15a), and (15b), results are reported in Table 5. Based on the results obtained in Table 5, the coefficients of the variance equation are positive and <1. The ARCH effect is tested using Ljung-Box Q statistics. The null hypothesis of the presence of ARCH effect is rejected at 5% level. Thus, GARCH (1,1) is possible to be executed (Kose and Baimaganbetov, 2015).

The main Equation (14) is estimated using ordinary least squares and results are reported in Table 6. Results represent the effect of the oil price shocks, OIL^{shock} on consumption expenditures.

Table 3: VEC, and VAR Granger causality/block exogeneity wald tests

VEC Granger causality/block exogeneity wald tests			
Dependent variable D (shock)			
Excluded	**Chi-square**	**df**	**P**
D (oil revenue)	0.141681	2	0.9316
D (consumption)	0.008648	2	0.9957
Dependent variable D (Oil revenues)			
D (shock)	18.0376	2	0.0001
D (consumption)	0.11132	2	0.9459
Dependent variable D (consumption)			
D (shock)	0.91180	2	0.6339
D (oil revenue)	4.43268	2	0.1090
VAR Granger causality/block exogeneity wald tests			
Dependent variable shock			
Oil revenue	0.77676	2	0.6782
Consumption	0.276779	2	0.8708
Dependent variable oil revenue			
Shock	11.38528	2	0.0034
Consumption	0.027291	2	0.9864
Dependent variable consumption			
Shock	0.807595	2	0.6678
Oil revenue	5.756422	2	0.0562

VEC: Vector error correction, VAR: Vector autoregression

A 1% increase in the oil price shock leads to an increase in consumption by about 10%. The effect of oil price shock on consumption is positive, as expected a priori and significant at 1% level. The P value is 0.0010 on the other hand, as a major oil exporting country, Saudi Arabia capability of producing massive quantities of oil, makes the economy to some extent can absorb the negative oil shock in the short and medium run. Oil revenues are considered the main factor of incomes in most of oil producing countries, among the Saudi Arabia. The use of it as explanatory variable is warranted, because big portion of income stems from the sales of oil. The impact of oil revenue variable OR_t on consumption expenditure is positive and significant at 1% level. The transmission effects of the (increase or decrease) of oil prices takes time to be materialized. Hence, consumption lagged 1 year had a positive impact over consumption expenditures and significant at 1% level. It is of

Table 4: Pairwise Granger causality tests, lags 4

Null hypothesis	Observations	F-statistic	P
Oil revenue does not Granger cause shock	27	0.33002	0.8541
Shock does not Granger cause oil revenue		5.78629	0.0036
Consumption does not Granger cause shock	27	2.20789	0.1090
Shock does not Granger cause consumption		3.48263	0.0283
Consumption doesn't Granger cause oil revenue	27	0.28722	0.8824
Oil revenue doesn't Granger cause consumption		3.58321	0.0256

Table 5: AR(1)-GARCH(1,1) model results

Variable	Coefficient	Z-statistic	P
Mean equation			
Constant	1.0000	7.99E-7	1.0000
ΔOP_{t-1}	1.0000	3.53E-7	1.0000
Variance equation			
Constant	8.15E-30	0.205078	0.8375
e_{t-1}^2	0.150000	0.146300	0.8837
h_{t-1}	0.600000	0.332292	0.7397

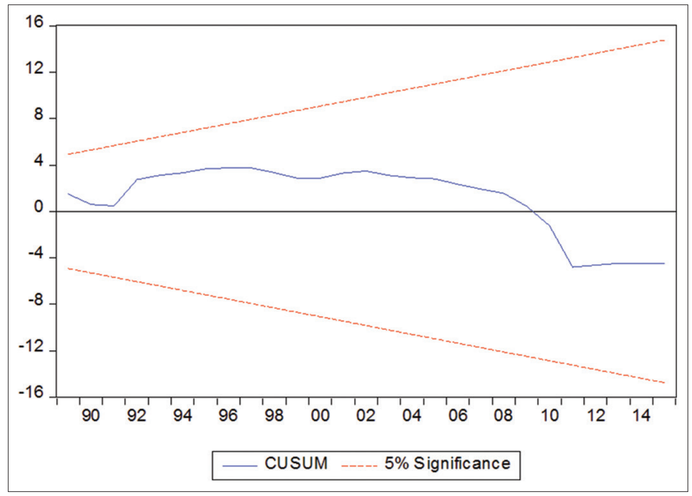
AR: Autoregression, GARCH: Generalized autoregressive conditional heteroskedasticity

Table 6: OLS estimates of consumption function

Dependent variable: Consumption			
Variables	**Coefficient**	**t-statistic**	**P**
C	1.00	9.41E-14	0.0000
OIL^{shock}	10.3630	3.69389	0.0010
Oil revenues$_t$, OR_t	5.13E-14	5.17444	0.0000
Consumption$_{t-1}$, C_{t-1}	1.00	1.71E+14	0.0000

R^2: 1.00, F: 1.38E+28. OLS: Ordinary least square

Figure 3: Cumulative sum stability test of the model



interest to check the degree of acceptance of the model. R^2 is about 1.00, and the F statistics is significant at 0.05% level. There is no serial correlation. The P > 5% indicating the rejection of the null hypothesis. In addition, no heteroscedasticity exists. Residuals are normally distributed which is also a good sign. However, since there is no serial correlation the, model is well accepted and OLS in this case is best linear unbiased estimator. Finally, cumulative sum stability test is presented in Figure 3. It indicates that the model is stable.

3.6. The Impulse Response Function

To see the responsiveness of the oil price shocks, OIL^{shock}, OR_t, and C_t, I follow the standard literature, Pfaff (2008). Given that all variables in the VAR(p)-process are integrated of order one, I(1). A VAR(p)-process can be written a VAR(1)-process, such that:

$$\zeta_t = \begin{bmatrix} y_t \\ \vdots \\ y_t - p + 1 \end{bmatrix}, \; A \begin{bmatrix} A_1 & A_2 & \cdots & A_{p-1} & A_p \\ I & 0 & \cdots & 0 & 0 \\ 0 & I & \cdots & 0 & 0 \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & \cdots & I & 0 \end{bmatrix}, \; \varepsilon_t = \begin{bmatrix} \varepsilon_t \\ 0 \\ \vdots \\ \vdots \\ 0 \end{bmatrix} \qquad (19a)$$

The dimension of ζ_t and ε_t is ($K_P \times K_P$) and the dimension of the matrix A is ($K_p \times K_p$). Stability of the VAR(p)-process requires that the moduli of the eigenvalues of A are less than one. Given endogenous variables $y_1, \ldots, y_T$ and sufficient pre-sample value $y_{t-p+1}, \ldots, y_0$, the coefficient of a VAR(p)-process might be estimated by OLS. After estimation of a VAR(p) model, scholars might look at diagnostic tests such as autocorrelation, casual inference, impulse response functions, and forecast error variance decomposition. The VAR(p) can be defined as:

$$y_t = \Phi_0 u_t + \Phi_1 u_{t-1} + \Phi_2 u_{t-2}, \qquad (19b)$$

Where, $\Phi_0 = I_k$ and Φ_s can be computed recursively such that:

$$\Phi_s = \sum_{j=1}^{s} \Phi s - jA_j \text{ for } s = 1, 2, \ldots \qquad (19c)$$

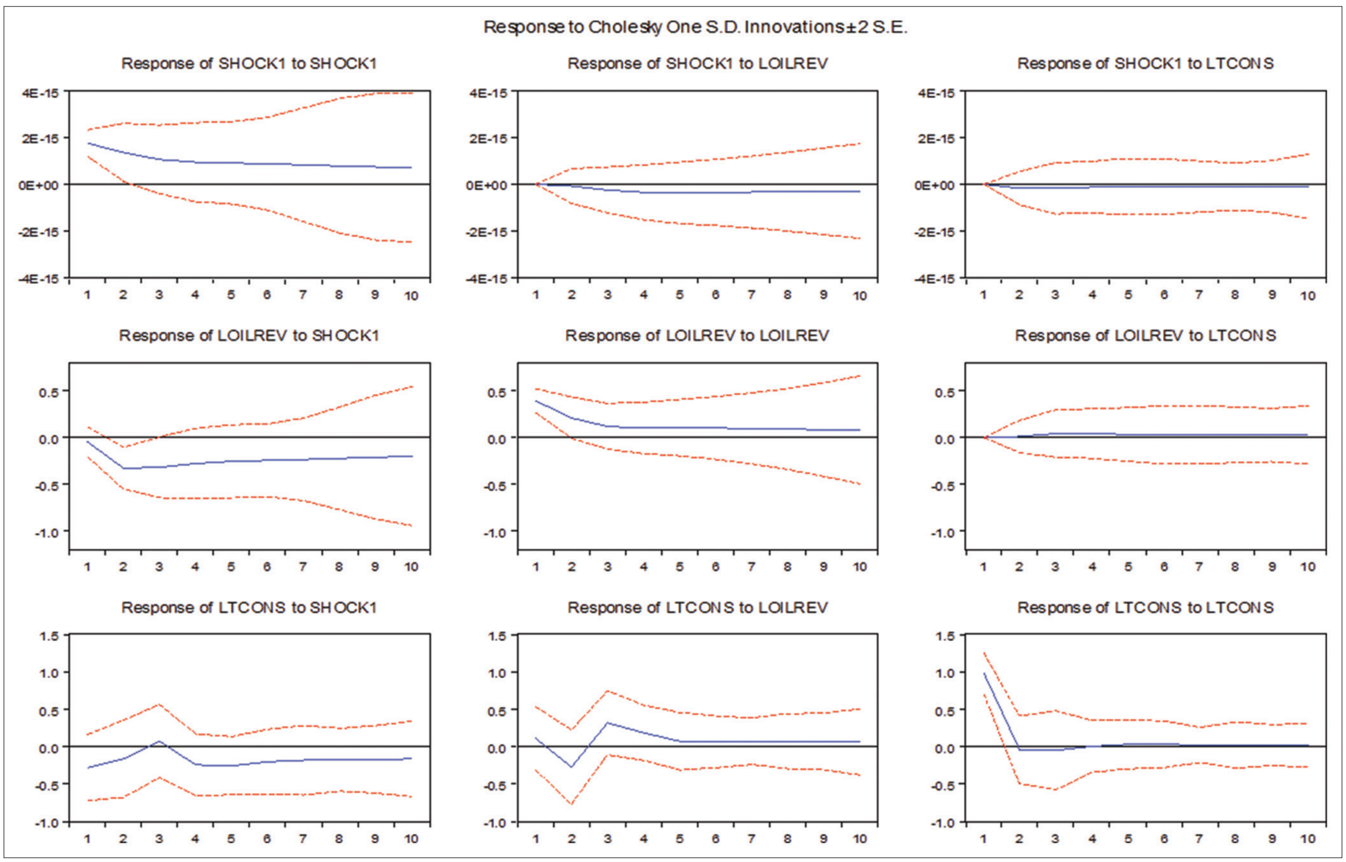
Where, $A_j = 0$, for $j > p$.

Using VAR, impulse response functions and variance decomposition functions are implemented to test the interactions and consolidate the causal relationships. If we simulate IRFs, the VAR innovations may be contemporaneously related, which means that a shock in one variable may be transmitted through contemporaneous correlation with innovations in other variables (Jalil et al., 2009). However, the impulse response functions from a VAR is guide us to whether the effects are short lived or permanent (Table 7). It shows dynamic properties of the model, which means the responses of dependent variables to unit shock of independent variables. However, it traces the effects of a one standard deviation shock in a certain variable on the current and future values of the rest of macro variables. Figure 4 shows the IRFs of each variable in the study to a one standard deviation shock in the oil price. The negative shock affected the earnings of the oil and this variable responded negatively till the 2nd year. It continued performing negatively for the rest of time span, 10 years. Similarly, consumption responded negatively, then increased till the 3rd year. After that the decline in oil prices and hence oil revenues compelled consumption to

Table 7: Impulse response to Cholesky, one SD innovations (asymmetric shock)

Period	Oil shock	Oil revenues	Total Consumption
Variance decomposition for oil shock			
1	1.76E-15	0.000000	0.000000
3	1.06E-15	−2.47E-16	−1.72E-16
5	9.08E-16	−3.75E-16	−1.11E-16
7	8.32E-16	−3.35E-16	−1.07E-16
9	7.47E-16	−3.05E-16	−9.61E-17
Variance decomposition for oil for oil revenues			
1	−0.045777	0.395674	0.000000
3	−0.318422	0.120383	0.042042
5	−0.254909	0.104899	0.033744
7	−0.234810	0.096848	0.029829
9	−0.211775	0.086232	0.027305
Variance decomposition for total consumption			
1	−0.280071	0.113409	0.986345
3	0.077187	0.319844	-0.048089
5	−0.253577	0.0737764	0.032610
7	−0.180386	0.074463	0.024330
9	−0.168859	0.069918	0.021291

Figure 4: Responses of oil revenue OR_t, and consumption C_t to asymmetric real oil price shock



act negatively and continued for the next 10 years. The IRFs is consistent with the causality tests where he effects run from oil price shocks to oil earnings then consumption. Looking at the negative oil price shocks (from the point of view of oil producer), a one standard deviation shock to negative oil price causes oil earnings to decline on average negatively by (−21) percent, and continue to become negative over the time span. On the other hand, total consumption declines, on average (−24) percent due to the decline in oil revenues which caused by the decline in oil prices in world oil market. It's worthwhile to note, that the fall in oil earnings accompanied by a fall in consumption. It is important to note *t* that, ECT is negative and is about 2%. The estimates indicate that the error correction term has a negative sign and is not significant at 5% level. This finding shows that, error correcting term, corrects the disequilibrium of the system at the rate of 2% annually. The result is warranted and shows the immense effects of the oil price shocks on the Saudi economy. Thus, decline in earnings, drop in consumption.

4. CONCLUSION AND POLICY IMPLICATIONS

No doubt that a major oil producer, Saudi Arabian, started to experience the sluggish effects of oil revenues. A way from the traditional analysis of oil price effects, this paper has examined thoroughly the effects of oil price shocks on total consumption variable covering the period of 1985-2015. The asymmetric oil price shocks will be investigated using unrestricted VAR model. The Johansen co-integration tests showed an existence of long-run relationships among the variables, a non-linear oil price shocks, oil revenues, and consumption. However, in the short-run, the findings showed that C_t, C_{t-1}, and oil revenues respond positively with asymmetric oil price shock (Table 6). The effect on consumption is about (−24) percent. On the other hand, the results showed that oil revenues responded positively to one standard deviation of asymmetric positive oil price shocks. The negative effects are about (−21) percent (Table 6). In assessing the oil price effects, the variance decomposition of VAR revealed that asymmetric oil price shocks contribution in forecast error variation in consumption and oil revenues is between 16% and 31%.

These findings are consistent with the results obtained from Equation (14). From Equation (14), a negative oil price shock (say 1%) causes a decrease in C_t by 10%. From the same equation, a negative decline in oil earnings (say 1%) leads to a decline consumption expenditures by 5.13E-14%. Similarly, from Equation (14), a negative decline in consumption last year (say 1%) causes a decrease in total consumption, by 1%. However, asymmetric positive oil price shocks have stronger and lasting effects in the long-run. Since, the government is the only collector of the oil earnings, and could help to mitigate the effects of such a negative effect on the growth of the economy, the use of fiscal policy is an important. Watching the economy downtrend is a bad sign of ignorance which will make the economy lose. The role of government is to strengthen the macroeconomic structure to help mitigating the negative effects via implementing policies that help to maintain growth. This paper's findings are in line with the findings of Ebele and Iorember (2015) concerning the impacts of asymmetric oil price shocks.

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