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AN IMPULSE RESPONSE FUNCTIONS ANALYSIS OF OIL PRICE EFFECT ON KEY ELEMENTS OF THE SAUDI ECONOMY

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ABSTRACT

This study has examined the dynamic effect of oil prices on key variables of the economy of Saudi Arabia. This study has investigated the dynamic effect of oil price variations on Saudi stock market index, industrial production, real exchange rate, and consumer price index. This study used monthly data that begun from January 1994 to September 2014 and analyzed the impact of oil price on relevant variables. The analysis was done using the granger causality test, variance decomposition analysis, and impulse response functions. Findings of this work showed oil prices fluctuation have a positive impact on the variables of interest. The result showed that industrial production, stock market index, consumer price index and real exchange rate exhibited a positive response to a one unit shock in oil prices. Thus, the results have confirmed that industrial production; consumer price index, stock market index, and real exchange rate can be translated dependent on the oil price variation. Thus, this study has provided the understanding of the interaction between oil prices and key variables of the Saudi economy.

INTRODUCTION

Oil is one of the most important factors that affect the economy of Saudi Arabia [1]. The global economic performance remains highly correlated with oil prices. Oil prices increase leads to a transfer of wealth from importing to exporting countries through a shift in the terms of trade [2]. The magnitude of the direct effect of a given price increase depends on the share of the cost of oil in national income, the degree of dependence on imported oil and the ability of the end-user to reduce their consumption and switch away from oil. The pattern in oil income has likewise influenced the nation's gross domestic product (GDP) as the income from oil comprises an enormous extent of GDP [3].

Oil enrichment encouraged remarkable financial and social advancement in Saudi Arabia. Since the 1970s, income generated from oil has empowered financial flourishing through enormous spending on foundation, interest in human capital and arrangement of a wide scope of social administrations [4]. Thus, oil prices assumes noteworthy role in producing income for the Saudi administration, which invigorates the wide range of financial exercises in the economy [5]. However, the decrease in oil prices in the world market and subsequent decrease in oil income may force financial limitation on government expansionary strategy [6].

Various works have been reported in analyzing the effect of oil prices on economic growth. Ghalayini [7] examined the impact of oil-costs on revenue of oil-trading nations such as Russia, India, China, Organization of Petroleum Exporting Countries (OPEC) and Gulf Cooperation Council (GCC) and found that there was no noteworthy connection with the exception of a unidirectional connection from oil-costs to revenue in GCC nations. Altay et al. [8] analyzed the relationship among oil costs and economic yield development in Turkey, and found long run impact was exhibited from oil-costs towards GDP. Ijirshar [9] investigated the effect of oil income on economic development in Nigeria, and found an allover positive impact of oil income advancement on the economic development in Nigeria. Millington [10] scrutinized the impact oil-costs reduction on Canadian economy with regards to GDP, work, and duty incomes, and found that the fall in oil cost had an unfavorable effect on Canadian economy in terms GDP, work and duty income. Burakov et al. [11] evaluated the effect of oil costs' fluctuation on financial development in Russia and found extended connection between oil costs and financial development. Alhayki [12] examined the dynamic co-movements between oil prices and stock market returns in the GCC countries, and found that low correlation in the short term and high correlation in the long term, signifying that oil has a high effect on stock returns for the longer the period is. Nath Sahu et al. [13] studied the dynamic relationships between oil price shocks and Indian stock market, and found that the co-integration result indicates the existence of long-term relationship between oil price shocks and Indian stock market.

Kalyanaraman [14] studied the subsistence of the long term link between oil prices and the stock market prices in Saudi Arabia using monthly data from October 2008 to October 2013, and confirmed the presence of long-run and short-run association between oil prices and stock prices. Mensi et al. [15] examined the linkages between oil prices and Saudi financial exchange, and found proof of asymmetry and long memory in the contingent instability between oil costs and Saudi stock market.

Oil price increase leads to a transfer of wealth from importing to exporting countries through a shift in the terms of trade. Saudi Arabia is a major oil exporting country that is affected by the oil price variation [16]. Furthermore, the global economic performance remains highly correlated with oil prices. The price of oil per barrel has risen from $27.29 in January 2001 to $97.24 in March 2013 with a maximum of $113.39 on 29 April 2011 [17]. On the other hand, the prices began to drop from $97.5 January 2014 and reached 91.17 on September 2014 [18]. The unexpected decline in the price in the year 2014,

forced the oil exporting countries to review their budget and adjust it according to the new price. Exploring the effects of the price variation is of great importance in Saudi Arabia since the country major income is generated from exporting oil [19].

Thus, this study was done to investigate the dynamic effect of oil prices fluctuation on key variables of the economy of Saudi Arabia. This investigation was analyzed by including the recent oil price drop period in the international level. The time series collected for this study includes the industrial production, stock market index, real exchange rate, and inflation. The investigation is conducted on monthly time series data starting from January 1994 to September 2014.

METHODOLOGY

This study examined the dynamic effect of oil prices and the economic variables of Saudi Arabia. The economic variables in this study include industrial production, stock market index, real exchange rate, and inflation. It employed the Impulse Response Function Model analysis (IRFs) to demonstrate how the variables respond to innovation in the oil price variable. The Augmented Dickey–Fuller (ADF) test and the Philip Peron (PP) test are used to assess if the data is stationary. Then, the Granger Causality test was used to evaluate the direction of causality and the Variance Decomposition (VDC) was used to test the variance of the time series data. The oil price variable -in our analysis- is considered as the independent variable that affects the other variables under the study in this research.

The oil prices dynamic effect is analyzed using the Impulse Response Functions to estimate the response of the dependent variables to shocks in the error term. The following hypotheses were analyzed in this work. 1. An increase in oil prices affects economy growth positively. 2. An increase in oil prices affect stock market index positively. 3. An increase in oil prices affects inflation positively. 4. An increase in oil prices affect exchange rate positively. This paper employed the monthly time series data starting from January 1994 to September 2014. All the time series data employed are gathered from World Development Indicator published by the World Bank. However, oil price data are extracted from the Energy Information Administration (EIA), and Market Index data, represented by the Tadawul All Share Indices in Saudi Arabia (TASI) was collected from Bloomberg.

Result And Discussion

Unit Test Result

The first test is the unit root test using the Augmented Dickey-Fuller (ADF) and Phillips Perron (PP) test. The null hypothesis is that the data has unit root. The guideline for it is that if the probability is higher than 5%, then the null hypothesis is not rejected. If the probability is lower than 5%, then the null hypothesis is rejected. Referring to Tables 1 and Table 2, it is observed that the probability of each variables at the constant, constant and linear trend, and

none are all higher than 0.05. According to the variable probability guideline of the ADF and the PP tests, the null hypothesis is that the data has unit root. Thus, probability is higher than 5% the null hypothesis is accepted. Hence, all the variables are not stationary.

Table 1: The ADF test probability results for the data at level

	Consumer Price Index	Industrial production	Oil Prices	Real Exchange Rate	Stock Market
Constant	0.999	0.171	0.330	0.482	0.651
Constant and Linear trend	0.989	0.116	0.085	0.657	0.556
None	1.000	0.820	0.396	0.441	0.658

Table 2: The PP test probability results for the data at level.

	Consumer Price Index	Industrial production	Oil Prices	Real Exchange Rate	Stock Market
Constant	0.9997	0.0001	0.3577	0.5308	0.6297
Constant and Linear trend	0.9825	0.0000	0.0974	0.8250	0.5227
None	1.0000	0.7683	0.4231	0.3588	0.6398

After establishing that all the variables are not stationery at unit test level, the data were then tested using first difference. Referring to Table 3 and Table 4, it was observed that the probability of each variables at constant, constant and linear trend, and none are all lower than 0.05. Thus, according to the variables probability guideline of the ADF and the PP tests, the probability is lower than 5%, all the variables null hypothesis that they have a unit root are rejected. Thus, all the variables are stationary.

Table 3: The ADF Test probability results for the data at the first difference

	Consumer Price Index	Industrial production	Oil Prices	Real Exchange Rate	Stock Market
Constant	0.0000	0.0000	0.0000	0.0000	0.0000
Constant and Linear trend	0.0000	0.0002	0.0000	0.0000	0.0000
None	0.0000	0.0000	0.0000	0.0000	0.0000

Table 4: The PP Test probability results for the data at the first difference

	Consumer Price Index	Industrial production	Oil Prices	Real Exchange Rate	Stock Market
Constant	0.0000	0.0000	0.0000	0.0000	0.0000

Constant and Linear trend	0.0000	0.0000	0.0000	0.0000	0.0000
None	0.0000	0.0000	0.0000	0.0000	0.0000

Lag Length Selection

Referring to Table 5, the guiding rule in selecting the lag length of the analysis is to choose the lowest Akaike Information Criterion (AIC) and Schwarz information criterion (SIC). According to Table 5, the AIC and SC suggest a lag length of 2. Thus, this is the lag length used.

Table 5: AIC and SIC lag length selection

Lag	AIC	SIC
0	68.99138	69.06367
1	54.10155	54.53534
2	53.65981	54.45510
3	53.69439	54.85117
4	53.80423	55.32250
5	53.90621	55.78598
6	53.88159	56.12285
7	54.00071	56.60346
8	54.08002	57.04427

Granger Causality Test

After converting the time series data to be stationary and confirming lag length, the Granger causality test was employed to examine the causality direction. Referring to Table 6, the null hypothesis stating that the oil price does not granger cause industrial production, which is the proxy of the economic growth, is rejected because its corresponding probability is lower than 0.05. This means that oil prices variation cause the industrial production to change. This is consistent with the work of Marashdeh et al. [20] where it was stated that crude oil prices and its fluctuation has a significant impact on the industrial production. The economy of Saudi Arabia is highly dependent on oil and the majority of the income is generated from it and the petrochemicals industries. Thus, when the price variation occurs it affects the industrial production.

Based on Table 6, the null hypothesis stating that the oil prices variable does not granger cause real exchange rate which is variables to represent exchange rate is rejected because its corresponding probability is lower than 0.05. This means that oil price variation cause real exchange rate to change. This is consisted with the work of Basher et al. [21] where it was demonstrated that oil price variation has impact exchange rates. The exchange rate represents the value of the currency. It is helpful in evaluating the price competitiveness of a country, at the same time; it is a key factor in determining the revenues derived from exports. Thus, when the price variation occurs it affects the real exchange rate.

Based on Table 6, the null hypothesis stating that the oil prices variable does not granger cause stock market index which is Tadawul All Share Index (TASI) in Saudi Arabia is rejected because its corresponding probability is lower than 0.010. This means that oil price variation causes stock market index to change. This is consistent with the work of Huang et al. [22], where it was stated that there is significant connection between oil price and stock market index. Thus, when the price variation occurs it affects the real exchange rate.

Based on Table 6, the null hypothesis stating that the oil prices variable does not granger because consumer price index which is the measurement of inflation, is rejected because its corresponding probability is lower than 0.010. This means that oil price variation causes consumer price index (CPI) to change. This is consistent with the work of Alsalman [23] where it was confirmed that oil prices has significant influences on consumer price index. This is because the consumer price index reflects the change in prices for the average consumer.

Table 6: Granger causality null hypothesis results

Null Hypothesis	Probability	Conclusion
Oil Prices does not Granger Cause Consumer Price Index	0.0870	Reject
Oil Prices does not Granger Cause Industrial Production	0.0001	Reject
Oil Prices does not Granger Cause Real Exchange Rate	0.0003	Reject
Oil Prices does not Granger Cause Stock Market Index	0.0565	Reject

Variance Decomposition Test

Table 7 to Table 10 shows the variance decomposition results. Based on Table 7 to Table 11, OIL represents the oil price, CPI represents the consumer price index, IND represents the industrial production, REEX represent the real exchange rate and STK represent the stock market index.

Based on Table 7, in period 4, a shock or impulse in the CPI accounted for 96.94545 percent variation of the fluctuation in CPI. In period 24, a shock or impulse in the CPI account for 96.85670 percent variations of the fluctuation in CPI. In period 4, a shock or impulse in the oil prices accounts for 2.128102 percent variation of the fluctuation in the CPI. In period 24, a shock or impulse in the oil prices accounts for 2.177164 percent variation of the fluctuation in the CPI.

Table 7: Variance Decomposition of DCPI

Period	S.E.	DCPI	DIND	DOIL	DREEX	DSTK
4	0.006188	96.94545	0.097195	2.128102	0.540593	0.288664

8	0.006193	96.85680	0.123951	2.177108	0.550748	0.291397
12	0.006193	96.85670	0.123993	2.177164	0.550748	0.291398
16	0.006193	96.85670	0.123993	2.177164	0.550748	0.291398
20	0.006193	96.85670	0.123993	2.177164	0.550748	0.291398
24	0.006193	96.85670	0.123993	2.177164	0.550748	0.291398

Based on Table 8, in period 4, there is a shock or impulse in the industrial production account for 95.32472 percent variation of the fluctuation in industrial production. In period 24, a shock or impulse in the industrial production account for 95.20498 percent variation of the fluctuation in industrial production. In period 4, a shock or impulse in the oil prices accounts for 2.697322 percent variation of the fluctuation in industrial production. In period 24, a shock or impulse in the oil prices accounts for 2.752323 percent variation of the fluctuation in industrial production.

Table 8: Variance Decomposition of DIND

Period	S.E.	DCPI	DIND	DOIL	DREEX	DSTK
4	1.41E+09	1.496749	95.32472	2.697322	0.328680	0.152526
8	1.41E+09	1.548235	95.20510	2.752250	0.329076	0.165336
12	1.41E+09	1.548245	95.20498	2.752323	0.329078	0.165375
16	1.41E+09	1.548245	95.20498	2.752323	0.329078	0.165375
20	1.41E+09	1.548245	95.20498	2.752323	0.329078	0.165375
24	1.41E+09	1.548245	95.20498	2.752323	0.329078	0.165375

Based on Table 9, in period 4, there is a shock or impulse in the real exchange rate account for 85.95462 percent variation of the fluctuation in real exchange rate. In period 24, a shock or impulse in the real exchange rate account for 85.94029 percent variation of the fluctuation in real exchange rate. In period 4, a shock or impulse in the oil prices accounts for 12.69169 percent variation of the fluctuation in real exchange rate. In period 24, a shock or impulse in the oil prices account for 12.69337 percent variations of the fluctuation in real exchange rate.

Table 9: Variance Decomposition of DREEX

Period	S.E.	DCPI	DIND	DOIL	DREEX	DSTK
4	1.452327	0.96295	0.190320	12.6916	85.9546	0.200425

		1		9	2	
8	1.452583	0.964157	0.193429	12.69333	85.94037	0.208718
12	1.452583	0.964156	0.193431	12.69337	85.94029	0.208757
16	1.452583	0.964156	0.193431	12.69337	85.94029	0.208758
20	1.452583	0.964156	0.193431	12.69337	85.94029	0.208758
24	1.452583	0.964156	0.193431	12.69337	85.94029	0.208758

Based on Table 10, in period 4, there is a shock or impulse in the stock market index account for 90.92030 percent variation of the fluctuation in stock market index. In period 24, a shock or impulse in the stock market index account for 90.73639 percent variation of the fluctuation in stock market index. In period 4, a shock or impulse in the oil prices accounts for 6.130767 percent variation of the fluctuation in stock market index. In period 24, a shock or impulse in the oil prices accounts for 6.222191 percent variation of the fluctuation in stock market index.

Table 10: Variance Decomposition of DSTK

Period	S.E.	DCPI	DIND	DOIL	DREEX	DSTK
4	8.645949	1.197124	0.959587	6.206039	0.831190	90.80606
8	8.660530	1.248452	0.963870	6.222174	0.828823	90.73668
12	8.660601	1.248729	0.963895	6.222192	0.828813	90.73637
16	8.660601	1.248730	0.963895	6.222192	0.828813	90.73637
20	8.660601	1.248730	0.963895	6.222192	0.828813	90.73637
24	8.660601	1.248730	0.963895	6.222192	0.828813	90.73637

Thus, overall, based on the results in Table 7 to Table 10, it is observed that oil price can explain the other variables changes. Applying a shock to oil price is the main factor that affects the other variables. Oil price effect is similar in the long term and the short term. It is confirmed that industrial production; consumer price index, stock market index, and real exchange rate can be interpreted based on the oil price variation. This outcome is consistent with the works of Basher et al. [24] where it was stated that oil price has significant effect on most economic variables, and it determined the economic outcome of an oil exporting nation.

Impulse Test Function

Impulse response function analysis for the following variables: stock markets index, consumer price index, and industrial production are shown in Figure 1 to Figure 4, respectively. Based on Figure 1 to Figure 4, it was observed that the response of the variables to one standard deviation shock in oil price. Consumer price index has response positively to one unit of shock in oil prices. Industrial production has response positively in response to one unit of shock in oil prices. Real exchange rate has response negatively to one unit of shock in oil prices. Stock market index has response positively in response to one unit of shock in oil prices. The responses generated from a positive shock on oil prices are very small but noticeable as the applied chock return back to zero. This is consistent with the results of the Granger causality test and Variance Decomposition analysis that the oil prices dynamically affect stock market index, industrial production, consumer price index, and real exchange rate. The positive movement of stock market index, consumer price index, and industrial production is an indication of better performance of these variables when the positive oil price occurs. If the oil price increases, the income generated from the exports will increase as well. The price per barrel has risen from $27.29 on January 2001 to $97.24 on March 2013 [17]. The price reached a high level of $113.39 on 29 April 2011 that lead to higher income generation at that period which reflected positively on the key variables of the economy. On the other hand, when the international prices of oil began to drop from $97.5 January 2014 and reached 91.17 on September 2014 [18]. This impacted the mentioned variable negatively.

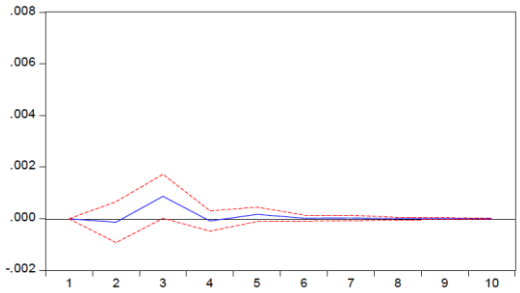

Figure 1: Impulse response of consumer price index to shock in oil price

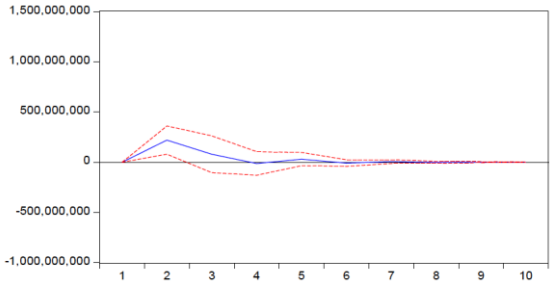

Figure 2: Impulse response of industrial production to shock in oil price

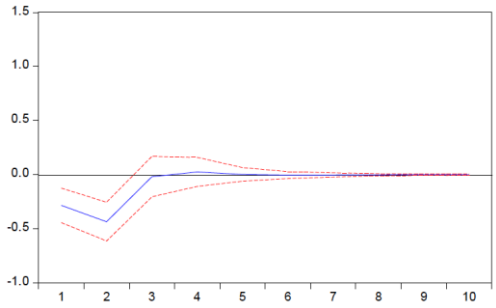

Figure 3: Impulse response of real exchange rate to shock in oil price

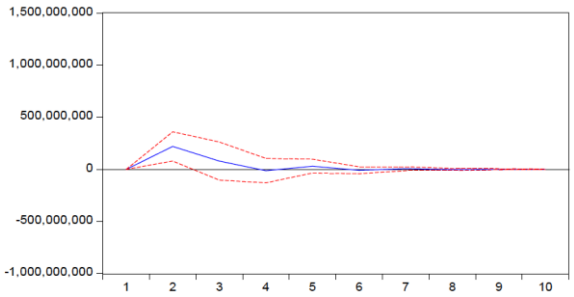

Figure 4: Impulse response of stock market to shock in oil price

CONCLUSION

This work has analyzed the dynamic effect of oil price on industrial production, stock market index, real exchange rate, and consumer price index. The outcome of this work has shown that the changes in oil prices cause stock market index, industrial production, real exchange rate, and consumer price index to change. Industrial production, stock market index, consumer price index, and real exchange rate have a positive response to a one unit shock in oil prices. Thus, it is concluded that that industrial production; consumer price index, stock market index, and real exchange rate can be interpreted based on the oil price variation. This means that the government and monetary agency officials should monitor oil prices in order to take the necessary action when needed.

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