

International Journal of Development and Conflict
7(2017) 97–118

THE ASYMMETRIC EFFECTS OF OIL PRICE ON ECONOMIC GROWTH IN TURKEY AND SAUDI ARABIA: NEW EVIDENCE FROM NONLINEAR ARDL APPROACH

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The immediate purpose of this paper is to examine and compare the potential asymmetric oil price effects on real GDP growth in two different countries with differing dependence on oil from the Middle East: Saudi Arabia and Turkey. Saudi Arabia is the major producer of oil in the global market while Turkey is a major user of oil from the region. How do oil price shocks impact on the economic growth of these two major economies from the Middle East? The analysis progresses in three stages: first, we offer a baseline model to explain how oil price shocks can have real effects through their impacts on inflationary expectations and relative price movements. Secondly, a linear ARDL model is tested to explore the long-run dynamics of relative prices and oil price changes. Thirdly, and most importantly, the empirical analysis employs an innovative nonlinear ARDL model proposed by Shin et al. (2014) to estimate the asymmetric long and short run impacts of oil prices. The empirical findings reveal that there is a strong evidence for a stable long run relationship between real GDP, oil price and other explanatory variables. In particular, the asymmetric analysis provides significant results on the difference of the economic growth responses to both positive and negative shocks of oil price. In the case of Saudi Arabia, real GDP response to positive oil shocks is important with larger magnitude compare to the negative shock. On the other hand, real GDP in Turkey react to a positive oil price shock is lower than its react to a negative shock. Our empirical results are extremely important for policy makers regarding the oil production process to achieve sustainable economic growth.

Keywords: Asymmetric Cointegration; Nonlinear ARDL; Economic Growth and Oil Price shocks

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1. Introduction

Since the early 20th century where oil seeps had been seen in the GCC region, oil has been one of the most appreciated natural resource. In the late 1960s international energy markets have experienced important structural changes and many oil exporting and importing countries have been affected by the oil price fluctuations (IMF, 2014). These price variations were associated with fluctuations in government budgets, trade imbalances and the overall economic performance and growth in many countries during 1970-2014 (Juet al., 2015). More precisely, the sharp fluctuations in the oil price could have different impacts on the real GDP growth and its sustainability on different economies. These impacts are subject to the degree of a country's dependence on oil and its economic diversification. The historical oil price breakdowns have imposed an interesting question that whether the response of economic growth to positive shocks in oil price is different from its response to a negative shock: i.e., whether oil price negative shocks have a greater influence on macroeconomic activities rather than the positive shocks (Çatık and Önder, 2013). This paper investigates the effects of oil price shocks on the real GDP of two different countries. On the one hand, we choose Saudi Arabia which is the world's largest crude oil exporter and has 18 per cent of the world's petroleum reserves. According to the Organization of Petroleum Exporting Countries (OPEC), the oil and gas sector accounts for about 50 per cent of GDP, and about 85 per cent of export revenues. Although, Saudi Arabia has a good fiscal position and a low level of foreign and domestic debt, the Saudi economy has recently adopted more prudent fiscal policies to address many structural challenges accompanying the period of lower oil prices. On the other hand we select Turkey as the 17th largest producer in the world, a net oil importing country that has a well-diversified economy. In 2014, International Energy Agency (IEA, 2014) has indicated that Turkey's crude oil imports are expected to double over the next decade.

Given the contrasting impacts of oil price decline, the oil price asymmetry puzzle is a real concern for many importing and exporting countries. Due to the economic and political prominence of impacts of oil price shocks, the asymmetric analysis of oil price shocks on the real GDP growth in these two different oil-dependence-countries is extremely important for various reasons. First and foremost, both Saudi Arabia and Turkey economies are highly dependent on oil a soil price changes will have crucial impacts on the fiscal deficits, trade balances and economic growth (IMF, 2014). Secondly, oil production and oil price have experienced a sharp fluctuations accompanied by sever political tensions for the economies of Turkey and Saudi Arabia – as examples, Iran-Iraq war 1980-1988, invasion of Kuwait 1990, Gulf war 1991 and Iraq invasion 2003). Thirdly, although there are several empirical studies on the asymmetric effects of oil price shocks on output level, to our knowledge there is no study tackles this issue for Saudi Arabia and Turkey by using nonlinear ARDL model. To this end, this paper aims to examine the asymmetric effects of oil price on real GDP growth in Saudi Arabia and Turkey.

This paper seeks to contribute to the debate on the effects of the oil price shocks on the economic growth and the plan of the paper is as follows: We provide a brief literature review in subsection 2.1. In subsection 2.2 we explain by using a baseline model how oil

price shocks can have real effects through their impacts on inflationary expectations and relative price movements. In this subsection, we exploit a linear ARDL model to detect the long-run dynamics of relative prices and oil price changes. In Section 3 we employ the econometric test called the nonlinear ARDL model - proposed by Shin et al. (2014) - to estimate the asymmetric long and short run impacts of oil prices for these economies. We conclude in Section 4.

2.1 A Brief Review of the Literature on the Asymmetric Effects of Oil Price Shocks

Economists have long been fascinated by the impact of oil price shocks on macroeconomic performance since the influential paper of Hamilton (1983). The empirical literature has provided evidence on many countries and for different periods using different econometric methods on the oil-growth nexus. In general, these studies have emphasized the effect of oil price and oil price shocks on macroeconomic activity in two different econometric frameworks: linear and non linear symmetric. The first stream of these empirical studies has rationalized the negative relationship between oil price shocks and output level by using the linear frame work without emphasizing the asymmetry impacts of oil price shocks (Burbidge and Harrison 1984; Bohi, 1991; Lee et al. 1994; Lee and Ni, 2002 Huang et al. 2005). Recently, Zhao et al. (2016) have used a dynamic stochastic general equilibrium (DSGE) model to evaluate the impacts of oil price shocks. They examined the different types of oil price variations (supply shocks, demand shocks and aggregate shocks). Their results show that oil supply shocks are driven mainly by political events and produce short run effects on China's output and inflation. However, bot the demand and the aggregate shocks have a moderate long run impacts. In the same manner, Noguera-Santaella, (2016) has argued that political events (oil crisis of 1970s, Iran-Iraq war 1980-1988, invasion of Kuwait in 1990, Gulf war 1991 etc. (see Figure 1)) impact on the oil price positively over the period 1859 up to 2000 and after 2000 there is no significant impact on the oil price. In contrast, many empirical studies have examined the effects of oil price shocks based on VAR impulse responses and variance decomposition which may suggest an asymmetric impact. Herwartz and Plödt (2016); Kilian and Murphy (2012) and Inoue and Kilian (2013) have used a structural VAR and found a further evidence that oil price shocks have asymmetric macro economic impacts. Therefore, the empirical literature has documented many empirical studies that investigated the asymmetric response to oil price shocks, first by Mork (1989) and then by Mork et al. (1994), Hamilton (1996) and recently by Herrera et al. (2015). These studies have referred to the oil price asymmetry puzzle which notes that an increase in oil price has a negative impact on real GDP, whereas the decline has not been boosted the real GDP. However, the linear framework could be incorrect to estimate the response of macroeconomic variables and, hence, lead to misleading results (Katrakilidis and Trachanas, 2012). In particular, the oil price shocks could trigger a nonlinear behavior on the real GDP growth, such that the real GDP response to a positive shock is different from its response to a negative shock in oil price.

The second stream is based on the nonlinear model which first tested by Sadorsky (1999) by using threshold vector Auto regression (Çatık and Önder, 2013). The findings of

Sadorsky (1999) for the US have revealed that the oil price declines has not a significant effect compare with positive impact of oil price increases, which support the asymmetric performance of oil price. Huang et al. (2005) have also confirmed the asymmetric performance of oil price on macroeconomic variables in the US, Canada and Japan by using multivariate threshold VAR. Similarly, Rahman and Serletis (2010) have investigated the asymmetric effects of oil price shocks and monetary policy on the output level in the US by using a logistic smooth transition VAR and the impulse response function. Both Huang et al. (2005) and Rahman and Serletis (2010) argued that the degree of asymmetric impacts of oil price shocks on the economic activity is subject to the threshold level and the degree of oil dependence. Cologne and Manera (2009) have examined how oil price shocks influence the real GDP growth for the G-7 countries by using a Markov switching analysis. Their results show that oil price shocks are likely to be asymmetric. Recently, Çatık and Önder (2013) have examined the asymmetric relationship between oil price and output level for Turkey. They used a multivariate threshold VAR (TVAR) model to confirm the nonlinear relationship between oil price and macroeconomic activity. More precisely, they indicated that oil price has an impact on output and inflation after a certain threshold level. More recently, Malikov (2015) has used a trivariate bloc-structural VAR system as proposed by Kilian and Vigfusson (2011). This technique is followed to examine the asymmetries and nonlinearities in the relationship between the real oil price and macroeconomic aggregate.

It is imperative to mention that Shin et al. (2011, 2014) have proposed an innovation nonlinear cointegration framework based on nonlinear auto regressive distributed lag (NARDL). This method includes the exogenous variables as two separated time series constructed in their positive and negative partial sum to examine the asymmetric effect of the selected variables. To this end, NARDL approach is growing in importance to capture the asymmetric impacts of many economic variables. In particular, the responses of macroeconomic variables to exchange rate fluctuations (Ahmad and Hernandez, 2013; Delatte and Villavicencio, 2012; Verheyen, 2013), and the response of houses prices to price level (Katrakilidis and Trachanas, 2012). Furthermore, NARDL has been used to investigate the impacts of rainfall on the food grain production (Mitra, 2013) and the vertical price transmission mechanism in the US beef sector (Fousekis et al. 2016). Recently, Atil et al. (2014) have examined the asymmetric effects of crude oil price on the gasoline prices in the US by using NARDL. Similarly, Pal and Mitra (2015) have used NARDL to assess the relationship between the crude oil price and the pricing of oil products in the US and they found the clear evidence of asymmetric impacts of oil price variations.

Therefore, this paper extends the work of Çatık and Önder (2013) by investigating the asymmetric oil price shocks on the real GDP in Saudi Arabia and Turkey by using different innovative econometrics approach (NARDL) as proposed by Shin et al. (2011, 2014). The purpose of this paper is to capture the asymmetric responses of the real GDP to oil price shocks in Saudi Arabia and Turkey over the period 1970-2014. This paper contributes to the existing literature on the asymmetric impacts of oil price shocks in many aspects: First, the chosen time horizon is very important since it includes several political and economic events in the region, which were the main sources of oil price shocks. However these oil

price fluctuations caused by the severe political tensions in the Middle East region are related to the geopolitics of Saudi Arabia and Turkey. Secondly, this empirical analysis employs the recent innovative econometrics techniques NARDL approach to investigate the potential asymmetric effects of oil price shocks on real GDP. Although, this approach has been used recently to assess the impact of exchange rate or prices on macroeconomic activity, it is first here applied to examine the asymmetric responses of output level to oil price shocks in Saudi Arabia and Turkey.

2.2 Preliminary Analysis: Why Do Changes in Oil Price have Asymmetric Effects on the Real Economy in the Middle East?

This preliminary analysis explores the dynamic interaction between relative (oil) price changes and inflationary expectations, which can in turn explain the asymmetric effects of oil prices on the real economy in the Middle East. The analysis, though preliminary, is undertaken in a novel sample of relative prices in the context of the Middle East. To improve upon our understanding of asymmetric (real) effects, in Section 2, we examine the long-run dynamics of inflationary expectations and our main focus is on modelling the impacts of inflationary expectations and inflation rates on the oil price shocks.

The assumed correlation between various measures of cross-sectional relative price variation and aggregate inflation constitutes an old debate in macroeconomics: one of the first early studies is by Vining and Elwertowski (1976), which triggers the univariate research that highlights various forms of regression equations with the dependent variable being a measure of cross-sectional variability of a relative price while the rates of inflation, being a proxy for inflationary expectations, are the independent variables. It is widely held that the relative price variability is positively related to inflation (see Atkeson and Ohanian 2001 among others). An excellent early review of the literature is available from Weiss (1994), though Reindorf (1993) fails to agree with this sort of simplistic regression approach. Similar criticisms were raised in the findings of Amano and Macklem (1997), Ball and Mankiw (1995) and Suvanto and Hukkinen (2002) who argue that the dispersion of relative prices is an important determinant of inflation and fundamentally more important than the reverse causality.

In the early literature, especially in the 1970s and 1980s, economists have come to highlight the role of incorrectly-aligned expectations to explain how inflation, or inflationary expectations, impacts on the relative prices (see Lucas, 1973; Fischer, 1976; Barro, 1981; Hercowitz, 1981; Cuckierman, 1984). The backdrop of these models assumes rational-expectations and market-clearing but agents make mistakes in predicting unanticipated changes in the price level that are caused by unknown changes in money supply. An unanticipated change in the money supply results in changes in prices in individual markets, which come to be viewed by market participants as changes in relative prices. As demand and supply elasticities in individual markets tend to differ, these anticipated changes in relative prices result in changes in actual relative prices. Because there has been no change in real economic conditions, and assuming the full information, a fully anticipated change in the money stock has no effect on relative prices and hence on the real economy.

One can also rationalize the relationship between inflation and relative prices by appealing to the menu cost theory (see Mussa, 1977; Sheshinski and Weiss, 1977 and Rotemberg, 1980). These models treat inflation as exogenous and assume that there is a cost of changing prices (menu cost). As a corollary prices change only at discrete intervals. When the inflation rate goes up, prices are changed more frequently, but under reasonable assumptions, not often enough to maintain the previous dispersion of relative prices, which now widens. The fundamental assumption is that price changes are not coordinated and arise randomly in time. The dispersion of relative prices does not necessarily increase in such a model if, for example, wage adjustments through a cost-of-living clause become more frequent as the inflation rate increases. The menu-cost models have been criticized for introducing *ad hoc* menu costs. In Gangopadhyay and Gangopadhyay (2008), though there is no explicit menu cost – learning issues are shown to create endogenous menu costs. Because of the endogenous menu cost, inflation can cause changes in relative prices and thereby trigger long-term real effects on the economy. In what follows we posit the baseline model.

2.2.1 Baseline Model

Our baseline model is expressed as the following:

$$OWP = F(INFS, INFT, AVGDP) \quad (1a)$$

Where OWP is the ratio, or relative, price of oil (op) to the price of wheat (wp) in the global market expressed in constant US \$. We posit here that the wheat price is determined by the balancing of global demand and global supply while Saudi oil production influences the price of oil (op) and hence, OWP . In Lemma 1 we offer the economic justification of equation (1a):

Lemma 1: If the global wheat price is determined by global factors only, then the average GDP of the Middle East (AVGDP) will adversely impact on the global oil price since Saudi Arabia is the major exporter of oil to the global oil market by employing guest workers from the Middle East. As a result, AVGDP will have a negative impact on OWP under a set of conditions. For the same reason inflationary expectations in the Middle East can also impact upon the OWP.

Proof: See the Appendix.

As the appendix establishes that the interrelationship and causality between $AVGDP$ and OWP are empirical issues and one has to empirically assess their interrelationships. This is what we now undertake to establish the inverse relationship between $AVGDP$ and OWP and their causal impacts.

The relative price is postulated as a function (F) of inflationary expectations in Saudi Arabia ($INFS$) and Turkey ($INFT$) during 1968-2008. The variable $AVGDP$ is the natural logarithm of the average per capita GDP in the Middle East. The inflationary expectations in each country are measured by the actual inflation rates. Though correctly anticipated,

inflationary expectations have real effects since inflationary expectations and inflation rates have divergence across nations. In Table 1.1 we present the variables of interest:

Table 1.1: Description of Variables of Interest

Variable	Labelling	Transformation	Source
Inflationary expectations in Saudi Arabia- measured by inflation in Saudi Arabia	<i>INFS</i>		World Bank
Inflationary expectations in Turkey, which is measured by Turkish inflation	<i>INFT</i>		World Bank
Average GDP in the Middle East*	<i>AVGDP</i>	Natural Logarithmic	World Bank
Ratio of Oil Price (<i>op</i>) to Wheat Price (<i>wp</i>)	<i>OWP</i>		Earth Institute, World Bank

Source: Constructed by the authors.

In what follows we apply the cointegration analysis to investigate any relationship between relevant variables from their long-terms (dynamic) patterns. Here at the outset we emphasise that our study calls forth the cointegration analysis since most of economic and social variables have stochastic trends. In other words, the data have unit roots, which beg a question of the relevance of using cointegration methods. In clearer terms one can simply question the tenability of the usual regression methods to the relevant time-series variables with unit roots? The answer is that standard regression models are estimated with the standard assumption of stationarity, implying that the variables are not trending, or if they are, that the trend is a deterministic time trend and not stochastic. In other words, the economic variables are I(1) and not I(0), then regressing I(1) variables on each other creates enormous problems that the usual chi square statistic, F test and t distributions are no longer valid. Thus, there are statistical problems with applying standard statistical tools to I(1) variables (see Johansen et al., 2000; Juselius, 2006 among others). As the subsequent analysis shows, it is possible to examine the long-run co-movements between trending variables, as well as short-run dynamic adjustment and feed-back effects within the same model. Furthermore, the model allows us to focus on the shocks that had a long-run permanent effect on the variables of the system. In this sense, the analysis may potentially provide results on causal mechanisms in the long run. For this section, annual data from 1968-2008 are obtained from the development indicators of the World Bank and food prices are obtained from various local sources and supplemented by the consumer price index data obtained from the World Bank. The oil price data and wheat price data came from the Earth Policy Institute and downloaded from the website www.earth-policy.org. The data are expressed in natural logarithmic forms except for inflationary figures and relative prices being the difference between food price and oil price inflation rates. We employ the Johansen (1991) approach of detecting cointegration for examining the long-term relationship between relevant variables. As a prerequisite of cointegration analysis we undertake the unit root tests- Augmented-Dickey-Fuller (ADF), pperron and Zandrew tests - for both constant and constant trend terms and noted all variables to I(1) as some results reported in Table 1.2. We also used the minimisation of MAIC to determine the optimal

lag for each variable. After ensuring the variables are I(1) and their first differences I(0), we apply the Johansen approach to assess the long-term relationship (see Johansen, 1991). In Table 1.2 we present the basic tests for unit roots and optimal lags:

Table 1.2: Basic Tests for Unit Roots and Optimal Lags

Variable	Optimal Lag	ADF/pperron/Zandrews Tests	Integration
OWP	1	-2.04, -1.30, -3.69	I(1)
AVGDP	4 (Except AIC)	-2.17,-1.49, -3.97	I(1)
INFS	0	-1.9, dfgls^	I(1)
INFT	1	-1.98, -2.24, -2.91	I(1)
ΔWOP	1	-5.33 (ADF), -6.65 (pperron)	I(0)
ΔAVGDP	4	-2.99 (ADF)*, -6.07, -3.01	I(0)
ΔINFT	1	-6.09 (ADF), -3.98(zandrews)	I(0)

Note: Computed by the authors. *: 5% significance level, ^: ADF/pperron/zandrews tests suggest INFS is I(0)

Following the stationarity test as summarised in Table 1.2, we test for cointegration between the dependent and the explanatory variables as given by the general equation (1a). We admit at the outset that there is doubt about *INFS* being I(1). To overcome this difficulty, we will also apply the ARDL approach to examine the long-term correlation. The presence of cointegration is tested with the Johansen Likelihood Ratio (LR) statistics and Trace test. The test statistics from Table 1.3 indicate that there are two stable long-run relationships: i) first, we have a stable and long-run relationship between *AVGDP* as the dependent variable and *OWP*, *INFS* and *INFT* as the dependent variables. In the second row of Table 1.4 estimates of this long-run relationship are given. ii) Secondly, we choose *OWP* as the dependent variable and *INFS*, *INFT*, *AVGDP* as the explanatory variables. The third row of Table 1.4 gives this long-term relationship. The coefficients show that the inflationary expectations have (long-term) significant impacts on the real economy (*AVGDP*) as well as on the relative price (*OWP*).

Table 1.3: Ranks of Cointegrating Variables (Johansen Test)

Rank	Parameters	Eigenvalues	Trace Statistic	Critical Value
0	20	-	62.62	47.21
1	27	0.51	34.12	29.68
2	32	0.41	13.76*	15.41

Note: Constructed by the authors. *: Number of cointegrating equations

Table 1.4: The Long-run Cointegrating Relationships

Dependent Variable	OWP	INFS	INFT	Constant^	AVGDP
AVGDP	-0.17**	0.019***	-0.0064***	-6.56	-
OWP	-	0.11***	0.013***	38.45	-5.8***

Note: Computed by the authors using STATA. ***: Significant at 99%, ^: Johansen

Once we undertake the Granger causality tests, as reported in Table 1.5, we find the following: a) we note that *INFT* and all variables (*OWP*, *INFT*, *INFS*) collectively Granger cause the real economy (*AVGDP*) in the region. b) We find that the real economy (*AVGDP*) in the region has causal effects on the relative price (*OWP*). Thus, we note that the inflationary expectations causally impact on the relative price movements through its influence on the real economy (*AVGDP*). c) As expected, the causality tests show that the inflationary expectations in Saudi Arabia are not (Granger) caused by any of the chosen variables. d) However, we note that the inflationary expectations (*INFT*) in Turkey are Granger caused by the real economy of the region (*AVGDP*), the relative price (*OWP*) and also by the collection of all variables (*INFS*, *AVGDP*, *OWP*).

Table 1.5: Granger Causality Wald Tests

Dependent Variable (Equation)	Excluded Variable	Chi ²	Prob>Chi ²
<i>AVGDP</i>	<i>INFT</i>	5.54**	0.063
<i>AVGDP</i>	<i>ALL(OWP,INFS, INFT)</i>	10.66**	0.099
<i>OWP</i>	<i>AVGDP</i>	4.9**	0.086
<i>INFS</i>	<i>NONE</i>		
<i>INFT</i>	<i>AVGDP</i>	8.28*	0.008
<i>INFT</i>	<i>OWP</i>	9.37*	0.008
<i>INFT</i>	<i>ALL(AVGDP, INFS, OWP)</i>	13.98*	0.03

Note: Constructed by authors *: Statistically significant at 5%. **: **: Statistically significant at 10%

In the above analysis we have reservations about the non stationarity of *INFS*, since some test results suggest that *INFS* is I(0). If *INFS* is I(0), then we will need to test the cointegration by applying the ARDL model introduced by Pesaran et al. (2001) for estimating I(0) and I(1) variables in the same equation. If all the variables (*INFS*, *INFT*, *AVGDP*, *OWP*) are I(1) then the Johansen approach that we have chosen before is appropriate. In order to apply the ARDL approach, we note that none of the variables is I(2) and *INFT*, *AVGDP*, *OWP* are definitely I(1) and *INFS* is possibly I(0). So, in our exploratory analysis, we choose the relative price (*OWP*) as an independent variable and the rest of variables as independent variables. The ARDL bound test in Table 1.6 confirms that there is a long-term cointegrating relationship between *OWP* and the rest of the variables. Thus, our preliminary test results suggest that inflationary expectations, relative prices and the real economy in the Middle East have long-term cointegrating relationships regardless of whether *INFS* is I(0) or I(1) during the chosen period of investigation during 1968-2008.

Table 1.6: The Long-run Coefficients from the ARDL Bound Test

Dependent Variable	AVGDP	INFS	INFT	F-Stat	t-Test
OWP	8.37***	0.019*	-0.024***	7.22	-4.36

Note: Computed by the authors using STATA. ***: Significant at 99%,

3. Nonlinear ARDL: Data and Methodology

Our analysis is conducted in the following sequence: in subsection 3.1 we explain the data set. In 3.1.1 we offer the methodology and discuss our findings in subsection 3.2.

3.1 Data

The empirical analysis depends on annual data for Turkey and Saudi Arabia over the period 1970-2014. The data come from different sources. The real gross domestic product is collected from World Bank development Indicators. The employment and stock capital are collected from Feenstra and al. (2014) data base. The oil price is USD per barrel come from U.S. Energy Information Administration. We use the exchange rate to convert the price of oil to the local currency. All the selected variables are expressed in natural logarithm.

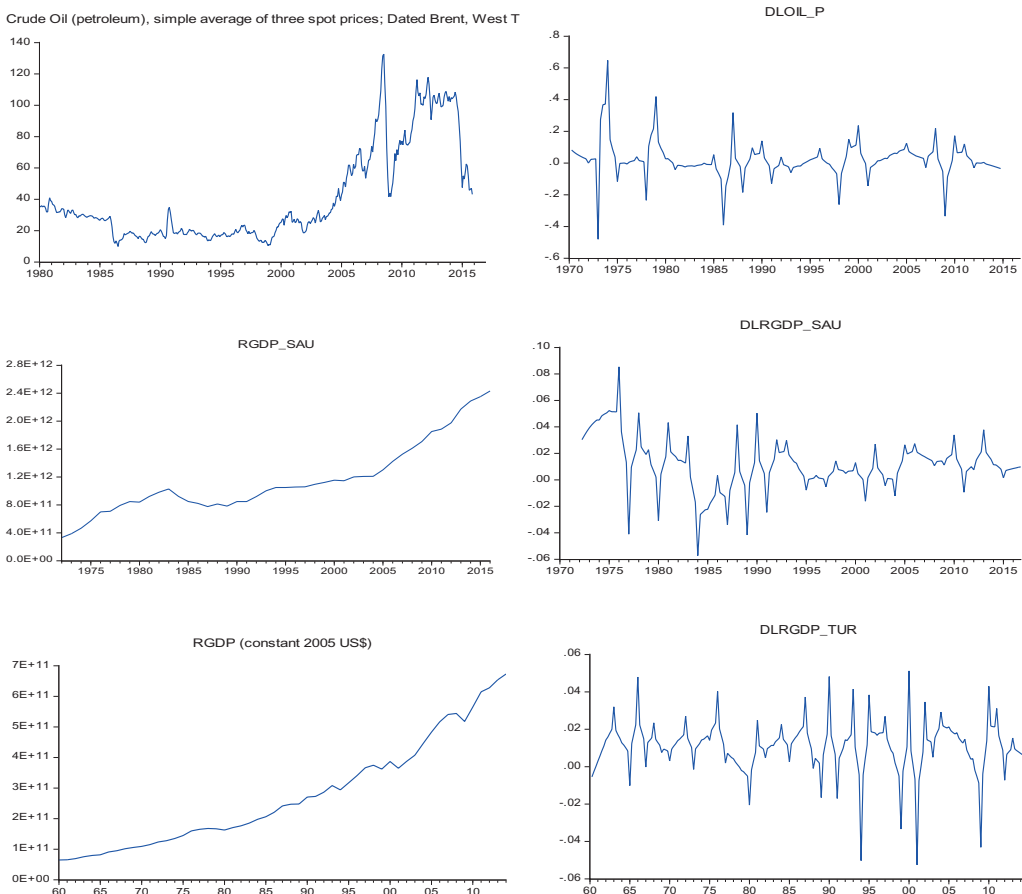


Figure 1: Oil price and real GDP developments in Saudi Arabia and Turkey 1970-2014

3.1.1 Methodology: The Nonlinear Autoregressive Distributed Lag model(NARDL)

Pesaran et al. (2001) have developed a linear cointegration autoregressive distributed lag model (ARDL) to evaluate simultaneously the long run and the short run effects. In such

model the dependent variable responds symmetrically to both increases and decreases in independent variable. Starting from simple Cobb Douglass equation the general equation of ARDL (p, q) is as follow

$$\Delta y_t = \alpha_0 + \rho y_{t-1} + aop_{t-1} + \tau w_{t-1} + \sum_{i=1}^{p-1} \alpha_i \Delta y_{t-i} + \sum_{i=0}^{q-1} b_i \Delta op_{t-i} + \omega_t \tag{1b}$$

Where: y is the real GDP; op is the oil price; w is a vector of deterministic variables and ω_t is an *iid* stochastic process. The symbol Δ denotes the first difference of variables. We say that the two variables y and op in eq. (1b) are not cointegrated if $\rho = a = 0$. Pesaran et al. (2001) have proposed the F-test to test the presence of cointegration in the estimated ARDL model. The decision is based on two critical bounds: the upper and the lower one. When the F-statistic is greater than the upper bound the null hypothesis is rejected. This means that there is a long run relationship between y and op . The ARDL model in equation (1b) assumes a linear combination of y and op which indicate a symmetric adjustment in the long and the short run of real GDP to any chock of oil price.

As we pointed out in the subsection 2.1, many empirical studies have argued the presence of the asymmetry effects of oil price increase or decrease on the macroeconomics variables such as economic growth. If the estimated model in eq. (1b) is nonlinear and/ or asymmetric relationship, the estimated results will be mis specified. Therefore the nonlinear and asymmetric ECM analysis is extremely important to assess the different real GDP responses in the presence of different oil price shocks. To this end, this paper will use the NARDL approach as proposed by Shin et al. (2014) to account for the asymmetry issue. Shin et al. (2014) have proposed the Nonlinear Auto-Regressive Distributed Lag model (NARDL) which allows studying simultaneously the dynamic long run relationship and asymmetries. This feature is the main advantage relative to other existing linear and nonlinear methods such as Error Correction Model (ECM), the threshold VAR (TVAR), the Smooth Transition ECM and the Markov-switching ECM. Additionally, the NARDL model can be used to test cointegration among variables even when the variables have not the same order of integration, dissimilar to the ECM which is mandatory in this sense. Furthermore the NARDL has the advantage to distinguish perfectly between the linear, the nonlinear or the absence of cointegration, (Katrakilidis and Trachanas, 2012). To investigate the short and long run response of economic growth to oil price decrease or increase we follow the methodology of Shin and al (2014). This method decomposes the oil price (op_t) into its positive (+) and negative (-) partial sums of increases and decreases as follow:

$$op_t = op_0 + op_t^+ + op_t^- \tag{2}$$

Where:

$$op_t^+ = \sum_{i=1}^t \Delta op_i^+ = \sum_{i=1}^t \max(\Delta op_i, 0)$$

And

$$op_t^- = \sum_{i=1}^t \Delta op_i^- = \sum_{i=1}^t \min(\Delta op_i, 0)$$

Following Shin et al. (2014) the nonlinear asymmetric ARDL model can be expressed as:

$$y_t = \beta^+ op_t^+ + \beta^- op_t^- + \mu_t \tag{3}$$

Where β^+ is the long run coefficient associated with the positive change in op_t and β^- is the long run coefficient associated with the negative change in op_t . Shin et al. (2014) revealed that by including eq. 3 in the ARDL (p, q) model presented in eq. (1b), we obtain the following nonlinear asymmetric conditional ARDL:

$$\begin{aligned} \Delta y_t = & \alpha_0 + \rho y_{t-1} + a^+ op_{t-1}^+ + a^- op_{t-1}^- + \tau w_{t-1} \\ & + \sum_{i=1}^{p-1} \alpha_i \Delta y_{t-i} + \sum_{i=0}^{q-1} (b_i^+ \Delta op_{t-i}^+ + b_i^- \Delta op_{t-i}^-) + \omega_t \end{aligned} \tag{4}$$

Where $a^+ = -\frac{\rho}{\beta^+}$ and $a^- = -\frac{\rho}{\beta^-}$

p and q denote the lag orders for the dependent variable and the independent variable, respectively. The NARDL method includes four stages. Firstly, the equation (4) is estimated by using the standard OLS. Secondly, the cointegration relationship between the levels of the series y_t , op_t^+ and op_t^- is performed by using the F_{pss} statistic proposed by Shin et al. (2014), which refers to the join null hypothesis of no cointegration ($\rho = a^+ = a^- = 0$). Thirdly, the long and the short run symmetric by using the Wald test is performed. For long run symmetry the null hypothesis to test is $a = a^+ = a^-$. For the short run symmetric the null hypothesis can take one of the following forms (i) $b_i^+ = b_i^-$ for all $i = 1, 2, \dots, q$ or (ii) $\sum_{i=0}^{q-1} b_i^+ = \sum_{i=0}^{q-1} b_i^-$. Finally, the nonlinear ARDL model in eq. (4) is used in order to derive the two dynamic multipliers (m_h^+ and m_h^-), the first one is associated with the change in op_t^+ and the second one is associated with the change of op_t^- :

$$m_h^+ = \sum_{i=0}^h \frac{\partial y_{t+i}}{\partial op_t^+}$$

$$m_h^- = \sum_{i=0}^h \frac{\partial y_{t+i}}{\partial op_t^-}$$

$h = 0, 1, 2, \dots$, Note that as $h \rightarrow \infty$ then $m_h^+ \rightarrow \beta^+$ and $m_h^- \rightarrow \beta^-$.

This empirical investigation for the paths of adjustment to the equilibrium will imply for the economic growth by using a nonlinear cointegration framework. Given that economic growth may be vulnerable to an initial positive or negative shock related to oil price, asymmetric analysis will add valuable information to the long and short run patterns of equilibrium.

3.2 Empirical Results:

All the selected variables are tested for the presence of unit roots by using Dickey- Fuller (1981) test. The results in table (1) shows that real GDP for SA is I(0), however the oil

price, the stock of capital and the employment are I(1).

Table 2a: ADF Unit root tests

	Saudi Arabia				Turkey			
	Level		First difference		Level		First difference	
	Intercept	Trend	Intercept	Trend	Intercept	Trend	Intercept	Trend
<i>y</i>	-4.05**	-4.11***	-3.90**	-4.018***	-1.32	-2.79	-6.5***	-6.65***
<i>op</i>	-2.4	-2.5	-6.3***	-6.4***	-1.65	-0.224	-3.67***	-4.22***
<i>K</i>	-2.21	-3.05	-2.64*	-3.59**	-1.91	-1.80	-2.70*	-3.22*
<i>L</i>	-1.63	-2.5	-2.67*	-3.17*	-1.40	-1.96	-4.49***	-4.52***

After we check the order of integration for all variables the next step is to examine the cointegration between these variables by using the linear ARDL bounds test for cointegration as presented in eq. (1). This first analysis will be a benchmark against which to assess the magnitude of any potential asymmetry.

$$\Delta y_t = cont + \rho y_{t-1} + \alpha_2 op_{t-1} + \alpha_3 K_{t-1} + \alpha_4 L_{t-1} + \sum_{i=1}^{p-1} a_i \Delta y_{t-i} + \sum_{i=0}^q c_i \Delta op_{t-i} + \sum_{i=0}^q d_i \Delta K_{t-i} + \sum_{i=0}^q e_i \Delta L_{t-i} + \omega_t \tag{5}$$

Table 2b: Bounds test for cointegration in the linear and the nonlinear specifications

Country		Linear ARDL ^a			Result
		F-statistic	95% lower bound	95% upper bound	
Saudi Arabia		3.19	3.23	4.35	No cointegration
Turkey		2.52	3.23	4.35	No cointegration
Country		Nonlinear ARDL			Result
		F-statistic	95% lower bound	95% upper bound	
Saudi Arabia	F_PSS	7.23	3.23	4.35	Cointegration
	t_BDM	-4.81			
Turkey	F_PSS	2.52	3.23	4.35	Cointegration
	t_BDM	-4.74			

The F-statistic for Linear ARDL and nonlinear ARDL represent the PSS F-statistic testing the null hypothesis $\rho = \theta = 0$ and $\rho = \theta^+ = \theta^- = 0$ respectively. *** 1% significance. a: Akaik criterion have been used to choose the p and q lags.

The empirical results of the linear ARDL bounds test for cointegration is presented in table (2). The estimated value of F-test reveals that the null hypothesis of no cointegration cannot be rejected. The explanation of this result can be interpreted by a possible nonlinear relationship between variables. Therefore, an alternative nonlinear ARDL bounds test is employed to investigate the long run nonlinear cointegration and check the possible asymmetric effects of the oil price on economic growth. The estimated nonlinear ARDL is based on the equation (4) which includes simultaneously the long and the short run of the

positive and negative partial sums. The maximum order of lags is chosen on the basis of the BIC information criterion.

Table 2 presents also the results of the nonlinear ARDL bounds test. This framework tests the existence of a long run cointegration between variables by using two tests: the first is the t_BDM test developed by Banerjee et al.(1998) which test the significance of the feedback coefficient ρ in eq. (4); the second is the F_PSS test proposed by Pesaran et al.(2001) which tests the significance of the variables that enter in eq. (4) in level. The results of the two tests exceeds the upper bound of the critical value, the null hypothesis of no cointegration is rejected and confirms the existence of a long run cointegration relationship between the selected variables in both countries Turkey and Saudi Arabia.

Table (3) and table (4) show the results of the short run and the long run dynamics of the real GDP response to the change in oil price. The nonlinear ARDL estimation provides the long and short run estimated coefficients for the different partial sums of oil price. The presence of an asymmetric impact in the long and short run is examined by the Wald test. This test checks the null hypothesis of symmetric against the alternative of asymmetric.

For Saudi Arabia the long run estimated results show that the coefficient is significant and has positive sign. The long run coefficient of OP^+ and OP^- are 0.17 and 0.086 respectively. This means that a 1% increase in the oil price causes a 0.17% rise in real GDP. Similarly a 1% decrease in the oil price causes a 0.086% fall in real GDP. Consequently the positive effect has the greater effect than the negative effect. The presence of an asymmetric impact in the short run is also examined by the Wald test. The results in the bottom of table (3) suggest the acceptance of the alternative hypothesis of the asymmetric for the case of oil price. More precisely, for the oil price the test shows a value equal to 15.27 (p-value = 0.02).

For Turkey the long run estimated results show different and opposite sign relative to the Saudi Arabia effects. The coefficients of partial sums are significant and have negative sign. The long run coefficient of OP^+ and OP^- are -0.026 and -0.22 respectively. This means that a 1% increase in the oil price causes a 0.026% decrease in real GDP. Similarly a 1% decrease in the oil price causes a 0.22% rise in real GDP. Consequently the negative shock has the greater effect than the positive shock.

By considering the asymmetric form described by the equation (4) we can analyze the dynamic effects between variables. We follow Shin and (2011) by using the dynamic multipliers to show the adjustment to equilibrium after a negative or a positive chock. Figures 2 and 3 show the dynamic effects of positive and negative changes in oil price where real GDP responds more rapidly to an increase in the oil price rather than its decrease in the case of Saudi Arabia and the opposite in the case of Turkey, achieving equilibrium nearly after few years. After a negative shock in SA (positive shock in Turkey) the adjustment to the equilibrium is achieved after less than 5 years.

Table 3: NARDL estimation results for Saudi Arabia

Variable	Dependent variable: $\Delta \ln Y$		
	Coefficient	P_value	T.stat
Constant	23.12***	0.00	5.30
$Y(-1)$	-0.613***	0.00	-4.80
OP_{t-1}^+	0.17***	0.00	4.70
OP_{t-1}^-	0.086**	0.04	2.08
$\Delta Y(-1)$	0.24	0.12	1.6
ΔOP_{t-1}^+	0.15***	0.001	3.93
ΔOP_{t-2}^-	-0.07*	0.09	-1.70
$K(-1)$	-0.54***	0.006	-3.42
$\Delta K(-2)$	0.92**	0.018	2.56
$L(-1)$	0.51***	0.001	3.83
$\Delta L(-1)$	-0.23*	0.56	-0.58
Asymmetric long-run coefficients	Long- and short-run symmetry tests	Statistics and diagnostics	
$LR_{lop}^+ = 0.27^{****}$	$W_{LR,lop} = 3.27^*$ (0.045)	$X_{SC}^2 = 35.67$ (0.01)	$X_{HET}^2 = 0.50$ (0.47)
$LR_{lop}^- = 0.14^{**}$	$W_{SR,lop} = 15.27^{***}$ (0.02)	$X_{NORM}^2 = 3.043$ (0.21)	$X_{FF}^2 = 1.52$ (0.24)

“+” and “-” denote positive and negative partial sums. LR^+ and LR^- are the estimated long-run coefficients associated with positive and negative changes, respectively.

$W_{LR,LRGDP}$, $W_{LR,IOP}$ refer to the Wald test for the null of long-run symmetry. $W_{SR,LRGDP}$, $W_{SR,IOP}$ refer to the Wald test for the null of the additive short-run symmetry condition.

***, **, * denote 1%, 5% and 10% significance level.

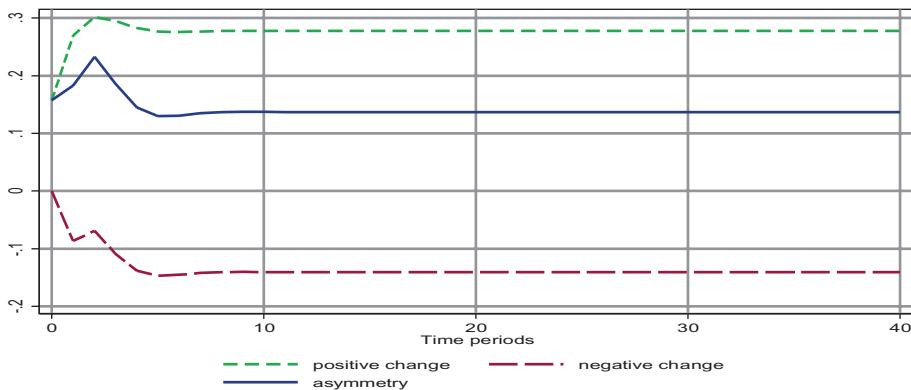


Figure 2: Long run and Short run multipliers in Saudi Arabia

Table 4: NARDL estimation results for Turkey

Variable	Coefficient	Dependent variable: ΔY	
		P_value	T.stat
$Y(-1)$	-0.80***	0.000	-4.60
OP_{t-1}^+	-0.026*	0.063	-1.97
OP_{t-1}^-	-0.17**	0.015	-2.65
$\Delta Y(-2)$	0.054	0.46	0.65
ΔOP_t^+	-0.029**	0.058	-2.02
ΔOP_t^-	-0.096**	0.18	-1.37
$K(-1)$	0.75***	0.002	3.95
$\Delta K(-1)$	1.30***	0.000	4.97
$L(-1)$	0.27**	0.18	1.38
$\Delta L(-1)$	-0.21	0.26	-1.15
Asymmetric long-run coefficients	Long- and short-run symmetry tests	Statistics and diagnostics	
$LR_{lop}^+ = -0.033^{**}$	$W_{LR,lop} = 5.88^{**}$ (0.045)	$X_{SC}^2 = 22.18$ (0.17)	$X_{HET}^2 = 3.827$ (0.0504)
$LR_{lop}^- = -0.22^{***}$	$W_{SR,lop} = 0.26$ (0.61)	$X_{NORM}^2 = 0.86$ (0.64)	$X_{FF}^2 = 2.602$ (0.1003)

“+” and “-” denote positive and negative partial sums. LR^+ and LR^- are the estimated long-run coefficients associated with positive and negative changes, respectively.

WLR, LRGDP, WLR, IOP refer to the Wald test for the null of long-run symmetry. WSR, LRGDP, WSR, IOP refer to the Wald test for the null of the additive short-run symmetry condition.

***, **, * denote 1%, 5% and 10% significance level.

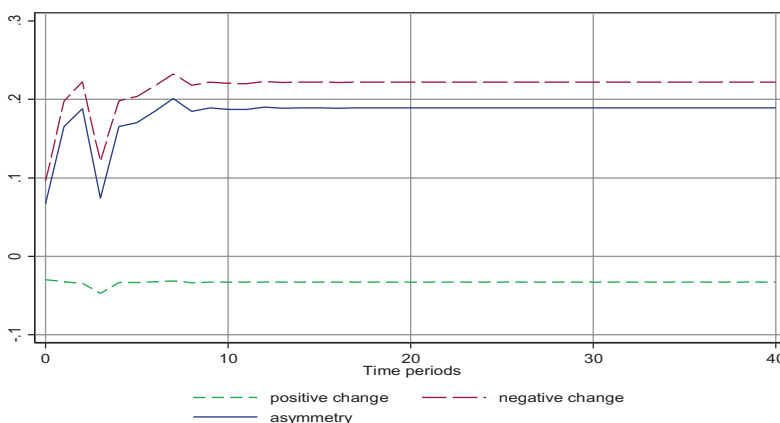


Figure 3: Long run and Short run multipliers in Turkey

4. Concluding Comments

In the preliminary analysis the standard cointegration tests and the ARDL bound test confirm that there is a long-term cointegrating relationship between inflationary

expectations, relative prices and the real economy of the Middle East during the chosen period of investigation. As a result, we argue that asymmetric oil price shocks can have non-trivial effects on the real GDP of Saudi Arabia and Turkey through their impacts on inflationary expectations and relative price dynamics. We thus show that asymmetric relative price movements or divergent inflationary expectations can engender asymmetric effects of oil price shocks in Saudi Arabia and Turkey.

We then consider the short run and the long run impacts of oil price shocks on the real GDPs of Saudi Arabia and Turkey. The upshot is that the nonlinear ARDL estimation provides both the long and short run estimated coefficients for the different partial sums of oil price shocks. The presence of asymmetric impacts in the long and short run is detected from the Wald test as this test checks the null hypothesis of symmetric against the alternative of asymmetric effects. For Saudi Arabia the long run estimated results show that the coefficient is significant and has positive sign such that a one percent (1%) increase in the oil price causes a 0.17% rise in real GDP. Similarly a one percent (1%) decrease in the oil price causes a 0.086% fall in real GDP. Consequently the positive effect has the greater effect than the negative effect for Saudi Arabia. The presence of an asymmetric impact in the short run is also noted. For Turkey, as expected, the long run estimates show the opposite signs relative with regards to Saudi Arabia: the coefficients of partial sums are significant and have negative sign. The long run coefficients of positive and negative oil price shocks are -0.033 and -0.22 respectively. This means that a one percent (1%) increase in the oil price causes a 0.17% decrease in real GDP. Similarly a one percent (1%) decrease in the oil price causes a 0.22% rise in real GDP. Consequently, as argued, the negative shock has the greater effect than the positive shock for Turkey.

APPENDIX 1

Proof of Lemma 1: In order explain equation (1a), we need to highlight the specific structure of the Saudi economy: the Saudi economy employs about 8.5 million workers, mainly in the oil extraction and related industries, and about 6.8 million workers are guest workers, or temporary migrants, mostly from the non-oil producing countries of the Middle East. So the Saudi wage rate is critically dependent on the reservation wages of the guest workers in their respective countries. If the guest workers receive higher wages in their home countries, the host country must also raise wages to attract the guest workers. If guest workers receive a lower wage rate in their home countries, the host country can lower its wages to guest workers, which will have real effects on the host economy. What we argue is that there is a positive relationship between the domestic wage rate in the home countries of workers in the region and the average GDP (*AVGDP*) of the region. The *AVGDP* is an indication of labor absorption in the Middle East and home wages for guest workers. If *AVGDP* rises (falls), the home wages will rise (fall) and the host country will be forced to reduce (increase) oil supply due to cost increases. In order to establish the relationship let us consider the (direct) profit functions from oil production in Saudi Arabia:

$$\Pi_S(Y, P, W) = P*Y - C(W, Y) \quad (1b)$$

P: Price of Oil, *Y*: Oil Output Produced by Saudi Arabia, *C(.)*: Cost of Oil production, *W*: Wage rate in Saudi Arabia

Let us define the maximized profit as Ω and given by

$$\Omega(Y, P, W) = \underset{\{Y\}}{\text{maximum}} \Pi_S(Y, P, W) \quad (1c)$$

$$\Omega(Y, P, W) = P*Y^O(P, W) - WX^O \quad (1c1)$$

where Y^O and X^O are the supply of oil and demand for labour by Saudi Arabia. From Hotelling's lemma we know that

$$\frac{\partial \Omega}{\partial P} = Y^O \text{ and } \frac{\partial \Omega}{\partial W} = -X^O \quad (1d)$$

Now the wage rates in the home countries be assumed, for simplification, be equal and given by W^* . Note that W^* is determined by the balance of demand and supply of labour in the home countries:

$$\text{Demand for Labour} = \text{Supply of Labour} \quad (1e)$$

Given the supply of labour as a function of W^* :

$$W^* = F^{-1}(\text{Demand for Labour} - \text{Exogenous Component of Supply of Labour}) \quad (1f)$$

F^{-1} is the inverse function from the equilibrium condition (1e) in the labour market. Since the home demand for labour bears a positive relationship with the home GDP:

$$\text{Home Demand for Labour} = \Phi(\text{AVGDP}) \text{ and } \Phi' > 0 \quad (1f')$$

Substituting (1f') into (1f) we get

$$W^* = F^{-1}(\Phi(\text{AVGDP})) = \Gamma(\text{AVGDP}) \text{ \& } \Gamma' > 0 \quad (1g)$$

Note that Γ is the composite function.

If *AVGDP* changes then the following effect is noted on *W* (Saudi wage rate):

$$\frac{\partial \Omega}{\partial \text{AVGDP}} = \frac{\partial \Omega}{\partial W} \frac{\partial W}{\partial W^*} \frac{\partial W^*}{\partial \text{AVGDP}} = (-X^O)^* \frac{\partial W}{\partial W^*} \frac{\partial W^*}{\partial \text{AVGDP}} < 0 \quad (1h)$$

Since $\frac{\partial \Omega}{\partial W} < 0$ from Hotelling's lemma and the other two terms are positive, (1h) is always true. So, the *AVGDP* and the Y^O (optimal oil supply by Saudi Arabia) will bear an inverse relationship since Saudi Arabia will reduce its optimal supply Y^O due to an increase in cost. As the optimal supply of oil by Saudi Arabia falls, there are three possible effects due to well-known effects from oil price speculation:

- i. The world oil price will increase: this happens when other oil-producing nations follow Saudi Arabia to cut their production (some sort of herd behavior) anticipating a further rise in future oil prices.
- ii. The world oil price will decline if other oil-producing nations produce more anticipating future decreases in oil prices.
- iii. The world price will stay unchanged if the contraction of oil output by Saudi Arabia is exactly matched by an increase in oil output by other major oil-producing nations.

What happens to the *OWP*? There are more complexities: as the *AVGDP* in the Middle East rises (falls), the regional wage rate rises (falls) and, if the income elasticity of wheat is positive, the regional demand for food like wheat rises (falls). There are three possible effects on the global wheat price:

- i. No effect at all, despite the fact that the Middle East is one of the largest segments of the global wheat market. This may be because of very small size of the Middle East market relative to the global wheat market. Alternatively, the spike in demand for wheat in the Middle East is matched by fall in demand for wheat elsewhere.
- ii. Secondly, the wheat price will rise if other regions also experience similar wage increases and increases in demand for wheat and other food items.
- iii. Thirdly, the wheat price will fall if other regions experience sharp cuts in wages and a greater decline in demand for wheat.

From the above we note that the relationship between *OWP* and *AVGDP* is an empirical question:

- a) The *OWP* will decline under {(ii), (II)}, {(ii), (I)}.
- b) The *OWP* will decline {(i), (II)} when (II) is stronger than (i).
- c) Otherwise, *OWP* will rise or stay unchanged following an increase in *AVGDP*.

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