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Asymmetric Effect of Oil Price on the Terms of Trade: Evidence from Oil Exporting and Importing Countries

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Abstract
The oil price shocks are an important source that affect on TOT in both oil exporting and importing countries. Hence, this paper compares the effects of real oil price shock on TOT in both oil importing and exporting countries, using Panel Data technique and during 1980-2010. To the best of our knowledge, we applied the nonlinear approach in order to assess the asymmetric impact of the oil price shocks on TOT. The results show that the oil price shocks influenced the TOT in the oil exporting and importing countries, differently. So that, in oil exporting countries, positive (negative) oil price shocks have significantly positive (negative) effect on their TOT, while in oil importing countries, positive (negative) oil price shocks have significantly a negative (positive) effect on TOT. Furthermore, the findings reveal that in the oil exporting countries, the effect of negative oil price shocks on TOT is more than positive oil price shocks. While, in oil importing countries, it is converse.

Keywords: Terms of Trade; Oil Price Shock; Oil Exporting Countries; Oil Importing Countries.

JEL Classification: E64, F41

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1. Introduction

In recent years, our understanding of the nature of energy price shocks and their effects on the importing and exporting economies has evolved, dramatically. Figure 1 in appendix represents the percent deviation of the real oil price from its average value during 1970 -2009. It is evident that the real oil price repeatedly has experienced the large and persistent fluctuations. The sizable oil price increases occurred in 1973-74 (Yom Kippur War), in 1979-80 (Iran-Iraq War), in 1990 (Invasion of Kuwait), after 1999, between 2003 and mid-2008 (Iraq War and oil demand increases), especially. Also, the major oil price declines occurred in the early and mid 1980s (collapse of OPEC), in 1991, after the Asian financial crisis and in late 2008 (during the global financial crisis).

In general, the oil price effect has been analyzed under three different channels: the supply side, the demand side, and the terms of trade (TOT). The TOT expressed as the ratio of import to export price index. Thus, an improving in the country's TOT suggests that it achieves the more numbers of imported goods instead of the determined volume of export (Baxter and Kouparitsas, 2000). Also, TOT changes result in welfare consequences in trading partners in order that any TOT improving would enhanced the welfare, while any TOT deterioration would worsen it (Krugman and Obstfeld, 2003).

Overall, TOT changes depend on the nature and source of disturbance. The oil price shocks are an important source that affect on TOT in both oil exporting and importing countries (Backus and Crucini, 2000). So that, oil price increases cause the wealth transfer from importing to exporting countries through the TOT shifting. In other words, in most oil importing countries, oil price increases lead to weaken the balance of payment, thus put downward pressure to the exchange rate. Therefore, import and export become more expensive and less valuable, respectively. So, national income declines and the TOT become worse (Kim and Loungani, 1992; Backus and Crucini, 2000). While, in oil exporting countries, oil price increases causes upward pressure of exchange rate. So, export and import become more expensive and less valuable, respectively. Therefore, purchase power increase and the TOT improve (Korhonen and Juurikkala, 2007). Nevertheless, the Dutch disease syndrome is yet observed in most oil exporting countries (Van Wijnbergen, 1984).

Although, the general mechanism by which oil prices affect on economic performance, is well understood, but the dynamics and magnitude of these effects are still uncertain, especially the adjustment via the TOT shifting. The empirical literature has provided quantitative measures of the impact of oil price shocks on macroeconomic variables such as the growth rate of GDP and the inflation rate (Hamilton 1983; Leduc and Sill, 2004), employment (Lee and Ni, 2002), the stock market (Kilian and Park, 2009), and external balances (Kilian et al, 2009). But, the empirical studies in order to investigate the asymmetric effect of oil price on the TOT, is still scarce, in both oil importing and exporting countries. Hence, this paper provide an empirical study to show the asymmetric effect of oil price on the TOT in both oil exporting and importing countries, during 1980-2010.

Next section presents the literature related to the relationship between oil price and macroeconomic. Section 3 describes data and methodology. Section 4 presents results and analysis. Last section presents the conclusion.

2. Literature Review

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

Following Hamilton, some researches addressed the question that: Is there any stable relationship between macroeconomic variables and oil price? Some of them have argued that the instability of the relationship is due to misspecification in modeling. Hence, researchers have tried to suggest different functional forms (linear and nonlinear) for signifying the factual relationship. Mork (1989) investigated the likelihood of an asymmetric reaction respected to oil price decreases and increases. The result showed that GNP was correlated with the conditions of the oil market. Mork offered the specification of oil price shocks that separate increases and decreases, as follows:

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

$$Oilp_t^+ = max[0, (oilp_t - oilp_{t-1})] \quad (2)$$

Lee et al. (1995) studied the relationship between oil price shocks and real US GNP growth during the period 1949-1992. They point to the nature of oil prices is volatile, hence Morks's (1989) method is not sufficient, and

volatility has to be considered. Therefore, they presented GARCH model in order to extract conditional variance from real oil price changes as below and concluded that the positive oil price shocks are significantly negatively correlated with real GNP growth, but negative oil price shocks are not.

$$0_t = \alpha_0 + \alpha_1 0_{t-1} + \alpha_2 0_{t-2} + \alpha_3 0_{t-3} + \alpha_4 0_{t-4} + \varepsilon_t \quad (3)$$

$$\varepsilon_t | I_{t-1} \approx N(0, h_t) \quad (4)$$

$$h_t = \varphi_0 + \varphi_1 \varepsilon_{t-1}^2 + \varphi_2 h_{t-1} \quad (5)$$

$$SPOI_t = \text{Max}(0, \hat{\varepsilon}_t / \sqrt{\hat{h}_t}) \quad (6)$$

$$SPOD_t = \text{Min}(0, \hat{\varepsilon}_t / \sqrt{\hat{h}_t}) \quad (7)$$

Additionally, Elder and Serletis (2006) showed that the uncertainty of oil prices has a negative and significant effect on industrial production.

Hamilton (1996) suggested another form of non-linear transformation of real oil prices that is called the NOPI specification. In this specification, the difference between the increase in current period and the highest increase in the previous four quarters, is positive, and otherwise is zero. Thus, this specification removes price increases which correct recent decreases and captures the shock aspect in the oil price change. Hamilton defined net specification as follows, and concluded the net nominal oil price increases are significant to explain growth in the US real GDP.

$$noilp_t^+ = max[0, ((oilp_t) - max((oilp_{t-1}), \dots (oilp_{t-4}))] \quad (8)$$

$$noilp_t^- = min[0, ((oilp_t) - min((oilp_{t-1}), \dots (oilp_{t-4}))] \quad (9)$$

Hamilton (2003) claimed that oil price increases are much more significant for predicting GDP than decreases. Thus, if the goal is to predict GDP growth, it is suitable that nonlinear function of oil price changes should use.

Recently, Jimenez-Rodrguez and Sanchez (2005) investigated the oil price shocks effects on real economic activities for seven OECD countries, Norway and the Euro area as a whole. They applied a multivariate VAR analysis, and used both linear and non-linear models. The results show that oil price increases have a larger impact on GDP growth than oil price decreases. Moreover, the non-linear model provides more significant results.

Despite this fact that oil exporting countries have experienced large and major fluctuations as a result of oil shocks, great body of researches have analyzed the impacts of oil price variations in the developed oil importing countries and specially US economy (Jimenez-Rodriguez and Sanchez, 2005); such that only a limited number of studies have focused on oil exporting countries (Berument et al., 2010).

Raguindin and Reyes (2005) examined the oil price shock effects on the Philippine economy, using both linear and non-linear models, during 1981-2003. The impulse response functions for the linear transformation of oil prices showed that oil price shock led to a lengthened reduction in the real GDP. While, in the non-linear VAR model, oil price decreases have a greater effect on each variable's fluctuations than oil price increases.

Elanshasy et al. (2005) investigated the relationship between oil prices, governmental revenues, government consumption spending, GDP and investment by a VAR/VECM model and concluded that fiscal balance in both short and long run affects economic growth.

Olomola and Adejumo (2006) examined the effects of oil price shocks on output, inflation, real exchange rate and money supply in Nigeria in a VAR framework. They argued that oil price shocks do not have significant effects on inflation and output rate. Also, fluctuations in oil prices affect the real exchange rates and money supply in the long run which may lead to Dutch Disease syndrome.

Mirfacihi (2006) compared the impact of an increase of oil price on TOT between Saudi Arabia and U.S during 1970-2004. The results indicated that an increase of oil price has a negative impact on TOT in the net oil importing country, while in the net oil exporting country, it is not significant.

Mehrara and Niki Oskui (2007) investigated the sources of macroeconomic fluctuations in four oil exporting countries including Indonesia, Iran, Kuwait and Saudi Arabia, using a structural VAR approach. On the basis of Variance Decomposition and Impulse Response analysis, oil price shocks are shown to be the main source of output fluctuations in Saudi Arabia and Iran. But in Kuwait and Indonesia, output fluctuations were mainly found due to aggregate supply shocks. Also, Mehrara (2008) concluded that output growth is adversely affected by the negative oil price shocks, while oil hikes play a narrow role to stimulate the economy of oil exporters.

Aloui and Jammazi (2009) studied the relationship between oil price shocks and stock markets, using the two regime Markov switching EGARCH model. They detected two regimes including the low mean/high variance regime and the high mean/low variance regime. The results show that the oil price increases play a significant role for determining of the

volatility of real returns as well as the probability of the transition across regimes.

Recently, Farzanegan and Markwardt (2009) examined the relationship between asymmetric oil price shocks and major macroeconomic variables in Iran, during 1989-2006. The VAR model results show that the positive oil price changes have a strong positive effect on industrial output growth. Also, oil price shocks have a marginal impact on government expenditures. Moreover, the Dutch Disease syndrome is observed via real effective exchange rate appreciation.

3. Data and Methodology

This paper evaluates asymmetric effects of the real oil price on the TOT in 42 net oil exporting* and importing† countries, separately. The studied period is selected during 1980-2005, considering availability of TOT data. As well, the data are constant 2000 price USD and extracted from World Bank. The real oil price is calculated as the nominal oil price in USD that adjusted with U.S products index. This paper concentrates on the scaled specification (Lee et al., 1995), so takes the oil price volatilities into account. Hence, we used AR(4)-GARCH model of oil price, as follows:

The Mean equation:

$$O_t = \alpha_0 + \alpha_1 O_{t-1} + \alpha_2 O_{t-2} + \alpha_3 O_{t-3} + \alpha_4 O_{t-4} + \varepsilon_t \qquad (10)$$
$$\varepsilon_t | I_{t-1} \approx N(0, h_t)$$

The Conditional Variance equation:

$$h_t = \varphi_0 + \varphi_1 \varepsilon_{t-1}^2 + \varphi_2 h_{t-1} \qquad (11)$$

$$SPOI_t = \text{Max}(0, \hat{\varepsilon}_t / \sqrt{\hat{h}_t}) \qquad (12)$$

$$SPOD_t = \text{Min}(0, \hat{\varepsilon}_t / \sqrt{\hat{h}_t}) \qquad (13)$$

Where, the mean equation follows AR (4) process, and the Conditional Variance equation is under GARCH (1, 1) process. Also, h_t is scale of the oil price volatilities. This specification indicated that oil price is influenced by oil prices in the past time, as well as oil price fluctuations. The variables of $SPOI_t$ and $SPOD_t$ defined as the scaled oil price increases and decreases, respectively. In order to make the $SPOI_t$ and $SPOD_t$ series, we estimates GARCH (1, 1) model, firstly. Then, we compare the standard residuals with zero, so that, in $SPOI_t$ ($SPOD_t$), we put zero instead of the negative (positive) residuals.

Then, we used Panel Data Technique for estimation. Panel data Fixed effect estimation assumes that the difference among cross sections is captured by different intercept for each cross section. But, in random effect estimation feature of cross sections are non observable and randomly distributed and captured by the error terms that contain two parts (constant part and varies over time part). Also, for distinguishing between fixed effects and random effects model, we applied Hausman test. The null hypothesis in this test states that the random effects estimator is correct (Baltagi, 2005).

4. Empirical Results

Before estimating, an important step is to test the unit roots and stationary. More recently, Im et al. (2003, henceforth IPS) proposed the between-group panel unit root tests that permit heterogeneity of the autoregressive root under the alternative. Hence, we used the Im, Pesaran and Shin (IPS) unit root test that assumes the series are non-stationary. Thus, unable to reject the null hypothesis implies that variables have a unit root (it means that they are non-stationary). Table (1) presents the results of Im, Pesaran and Shin (IPS) unit root test. The results of IPS unit root test show that all variables are stationary at level. In other words, the variables are integrated of order (0).

Table 1: Results of the IPS unit root test for used variables

Variables	Level	Prob.	Result
SPOD	-3.71	0.001	I(0)
SPOI	-4.57	0.000	I(0)
$LTOT_x^*$	-2.74	0.003	I(0)
$LTOT_m^{**}$	-2.42	0.007	I(0)

***Source*:** Authors

*,** denotes as logarithm of TOT in oil exporting and importing countries, respectively.

Table 2 shows the estimation results as well as the Husman test results, for both oil exporting and importing countries. The null hypothesis in the Husman test implied that RE is a better method for estimating. The results indicate that in both oil exporting and importing countries, FE method is the appropriated method for estimating. The results using FE method show that the oil price shocks influenced the TOT in the oil exporting and importing countries,

* Equa Guinea, Canada, Iran, Nigeria, Ecuador, Gabon, Venezuela, Norway, Colombia, Argentina, Mexico, Denmark, Malaysia, Egypt, Lybia, Algeria, Angola, Saudi Arabia, Brazil, Congo Dem, Congo Rep.

† Japan, US ,China, Australia, New Zealand, India, Korea, Philippine, Sweden, Germany, France, Netherland, Portugal, Hungry, Austria, Poland, Spain, Italy, Finland, Greek, Ireland.

asymmetrically.

Hence, in oil exporting countries, positive oil price shocks have significantly positive effect on TOT, while negative oil price shocks have significantly negative effect on TOT. By contraries, in oil importing countries, positive oil price shocks have significant negative effect on TOT, but negative oil price shocks have a positive but non-significant effect on TOT. The results are in line with the wealth transfer effect which captures the transfer of income from oil-importing nations to oil-exporting nations following an increase in oil prices. The transfer of income reduces the consumer demand in the oil-importing countries, and increases at same time, the consumer demand in the oil-exporting countries. It causes pressure of exchange rate, differently so that the oil exporting countries' TOT improved, while the oil importing countries' TOT worsened.

Moreover, the findings reveal that in the oil exporting countries, the effect of negative oil price shocks on TOT is stronger than positive oil price shock. While, in oil importing countries, it is converse. Given, the exporting economies are highly depend on oil sector because of little export diversification. Thus, their TOT responded to negative oil price shocks more than positive shocks. But, in oil importing countries, the oil is main input for production process (supply effect).

Therefore, it is evident that their TOT responded to positive oil price shocks more than negative shocks.

Table 2: Results of Estimation for oil exporting and importing Countries

Dependent Variable: LTOT		
Variables	Oil Exporting Countries	Oil Importing Countries
SPOD	-2.56 (-2.81)*	0.31 (0.61)
SPOI	1.37 (2.99)	-1.18 (-2.21)
C	4.51 (18.69)	4.62 (56.07)
AR(1)	0.77 (12.04)	0.81 (11.72)
R^2	0.7907	0.7768
$\overline{R^2}$	0.7714	0.7532
F (prob.)	0.0000	0.0000
D.W	1.82	1.95
Husman test Prob.(0.05)	19.03 (0.0003)	18.66 (0.0009)

***Source*:** Authors
*denotes the t-statistics.

Overall, the empirical results reported in this table paper has compares the effects of real oil price shock on TOT in both oil importing and exporting countries during 1980-2010. To the best of our knowledge, we have applied the nonlinear approach in order to assess the asymmetric impact of the oil price shocks on TOT. The results show that the oil price shocks influenced the TOT in the oil exporting and importing countries, differently. So that, in oil exporting countries, positive (negative) oil price shocks have significantly positive (negative) effect on their TOT, while in oil importing countries, positive (negative) oil price shocks have significantly a negative (positive) effect on TOT, as expected.

The results have been in line with the wealth transfer effect which captures the transfer of income from oil-importing nations to oil-exporting nations following an increase in oil prices. Oil price increases leads to windfall oil revenue for oil-exporting countries. The transfer of income reduces the consumer demand in the oil-importing countries, and increases at same time, the consumer demand in the oil-exporting countries though more proportionally because of an assumed higher marginal propensity to consume in the latter (Kilian, 2010). Therefore, it causes upward pressure of exchange rate in oil exporting countries. Hence, export and import become more expensive and less valuable, respectively. Therefore, the oil exporting countries' TOT improved, while the oil importing countries' TOT worsened (Fried and Schultze, 1975; Dohner, 1981).

5. Conclusion

Our empirical findings have reveal that in the oil exporting countries, the negative oil price shocks have stronger effect on TOT than positive oil price shocks. While, in oil importing countries, it is converse. Given, oil exporting

economies are strongly dependent on oil revenues. Hence, government finance is heavily dependent on the oil sector. A negative oil price shock typically exposed governments to large pressure for financing. Hence the import of intermediated and capital goods would reduce, greatly. On the other hands, in these oil exporting countries, export diversification is little. Therefore, their TOT responded to negative oil price shocks more than positive shocks. But, in oil importing countries, the oil is main input for production process. A positive oil price shock produces a trade imbalance that, forces the currency of the oil importing country to depreciate to restore the balance. As a consequence of the depreciation, the oil importing country suffers a negative wealth effect and the oil exporting country a positive wealth effect, so that the terms of trade redistributes asymmetrically the cost of adjustments to positive oil price shocks in favor of the oil exporting country. This transmission mechanism makes it possible for a positive oil price shock to cause to the oil importing country an economic cost that, in terms of consumption loss, is larger than the share of oil costs in total output (supply channel). Therefore, it is reasonable that their TOT responded to positive oil price shocks more than negative shocks.

However, the results show that oil price fluctuations are key determinant of TOT in oil exporting and importing countries. These effects are considerable, if dependency to oil sector is strong. In oil exporting countries that oil export including major share of their export and since the real oil price face to large and persistent fluctuations, hence export diversification and expanding of non-oil export considering comparative advantage is on suitable way to keep away from TOT deterioration. Also, in oil importing countries, in spite of export diversification, oil price shocks influence on TOT via supply-side effect, hence applying substitution inputs for oil input is a policy for avoiding of TOT deterioration.

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Appendix

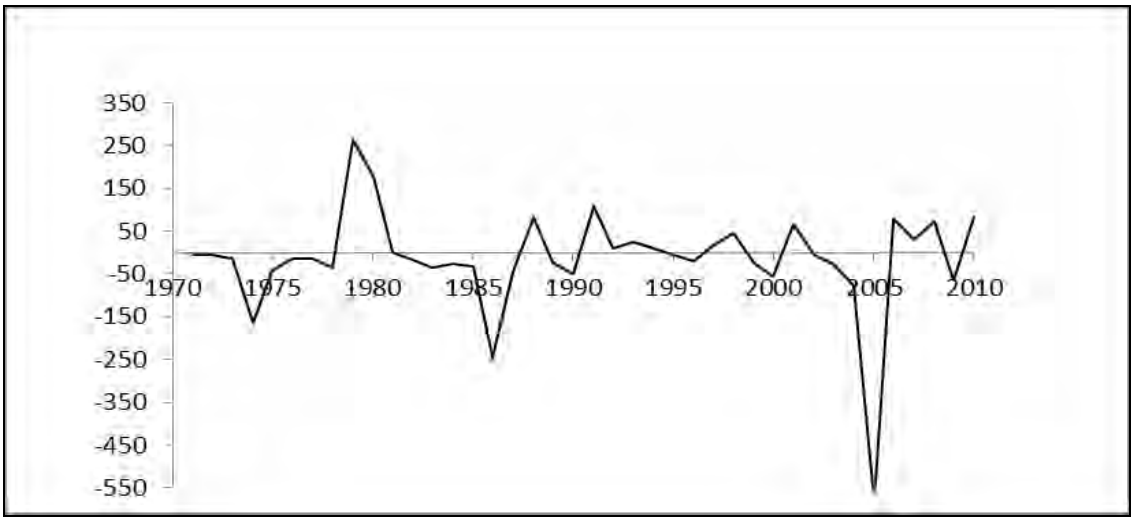

Figure1: Percent deviation of the real oil price from its average value during 1970-2010

***Source*:** Compiled by the Authors, using the extracted data from www.iea.org

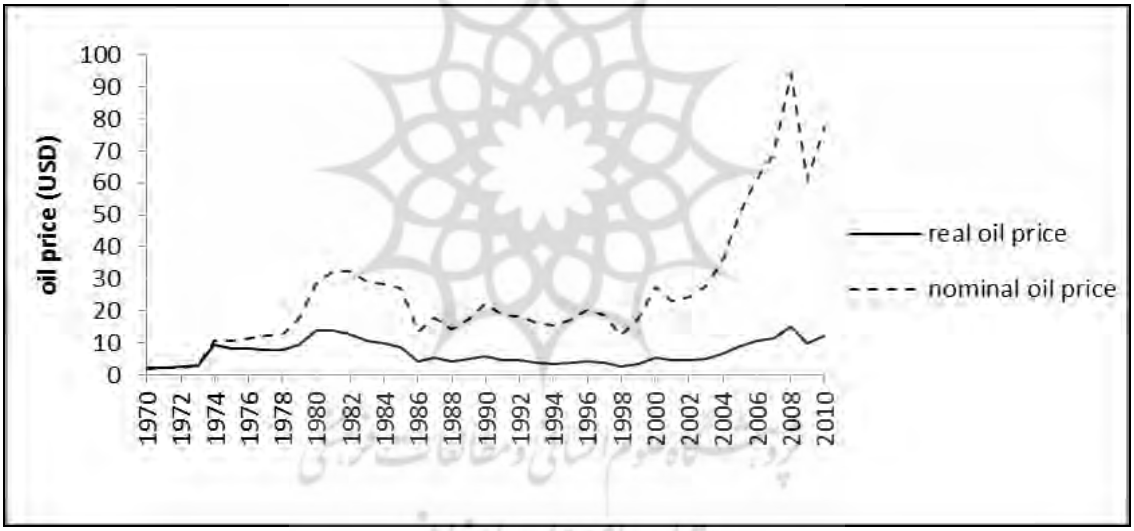

Figure2: The real and nominal oil price during 1970-2010

***Source*:** Compiled by the Authors, using the extracted data from www.iea.org