International Journal of Energy Economics and Policy
Vol. 4, No. 3, 2014, pp.457-464
ISSN: 2146-4553
www.econjournals.com

Asymmetry of the Oil Price Pass –Through to Inflation in Iran

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ABSTRACT: Due to the structure of Iran's economy, oil revenues do not have a multi-dimensional role rather than a one-dimensional role in inflation. To put it differently, oil revenues impact inflation through exchange rate, government budget, importation, and imported inflation, monetary base, GDP growth, and government investment. These factors sometimes have contradictory effects on inflation. Therefore, investigating and analyzing the pass-through of oil shocks into inflation and providing appropriate policies is quite essential. Hence, the present research is primarily aimed at modeling the pass-through of oil price and investigating its effect on inflation by means of hidden co-integration approach, analysis, and presenting political implications to control the effect of oil shocks on inflation. In order to do so, monthly data of crude oil and consumer price index from March 2003 to March 2013 have been utilized. The findings demonstrated the pass-through of oil price to the CPI in Iran. Moreover, the coefficient calculated in this study revealed that the magnitude of this pass-through is quite large in the long run in Iran's economy. In addition, based on the CECM model which is a type of non-linear, asymmetric, and hidden co-integration method this research showed that the pass-through of oil price to inflation is asymmetrical. On the other hand, the dynamic short-term relationship, in the framework of CECM model, also confirmed the asymmetrical pass-through of positive and negative oil shocks into inflation.

Keywords: oil price; inflation; Asymmetric Pass-Through; CECM model.
JEL Classifications: C13; C22; E31; Q43

1. Introduction

The influence of oil on a large number of economic activities all over the world has made it an absolutely crucial variable (Cavalcanti et al., 2013). Most studies indicate that oil will continue to have a large part in the world's energy consumption due to reasons such as easy transportation, the lack of an appropriate substitute in some domains, and its wide application. Therefore, it is evident that any change in oil-related variables such as supply, demand, and price will have worrying consequences for oil-producing and oil-consuming countries (Tiwari, 2013). These changes may sometimes disrupt the macro-economic system of these countries (Mehrara and Mohaghegh, 2011).

As a matter of fact, this is rooted in the positive oil shocks in the 1970's and the recession in the global economy in its aftermath. After this period, a great number of studies dealt with the impacts of the changes of oil market on macro-economic variable such as inflation (Subhani et al, 2012). Some of these studies are (Aastveit et al. (2013); Mehrara and Mohaghegh (2011); Trung and Vinh (2011); Tang et al (2010; Blake et al (2010); Lescaroux and Mignon (2008); Guo and Kliesen (2005)) Most of these researches demonstrated a negative relationship between increase in oil price and economic activities. During the 1980's when the global price of oil dwindled, it was expected that a boom in the global economy will dominate. This expectation was not met, leading to the emergence of the issue of asymmetrical effects of oil shocks on economic variables in the literature (Arinze, 2011). After this period, many studies explored the asymmetrical effect of oil price on the economy of developed countries that are mainly oil importers (Pavn and Sola, 1996). This line of research has also confirmed the non-linear relationship between the pass-through of oil price and inflation (Catik and Karacuka, 2012). A deep analysis of these studies reveals that the theoretical foundations of these non-linear and asymmetrical effects are related to three factors (L'oeillet and Licheron, 2008). First, if a country has a low level of inflation, the changes of oil prices would have a slight influence on the economy of that country. Second, changes in oil prices triggered by natural factors will not lead to a dramatic rise of inflation, whereas changes fueled by price changes in financial markets would have a significant impact on inflation. Finally, severe changes in the oil price have occurred in recent years which have had asymmetrical impacts on inflation (Chen, 2009).

Therefore, the literature confirms the asymmetrical and non-linear effects of oil shocks on most economic variables such as inflation. It is unquestionable that the increase of oil price slows down the growth of global economy because oil is not a final product, but is considered as a production input affecting all economic activities. Consequently, a change in the price of this material will pass through other products (Chou and Tseng, 2011).

Due to the position of oil in Iran’s economy, which is a single-product economy, great dependence of GDP on oil revenues, and the influence of international political and economic fluctuations, investigating the impact of oil shocks on economic variables is quite essential. In light of the role of oil in countries’ economy especially in the previous decade, the importance of inflation as one of the main problems of Iran’s economy, and recent oil shocks and their probable relation with price indicators, the main objective of this study is to examine the asymmetrical pass-through of oil price to inflation.

2. Iran's Economy and the Oil Asymmetric Pass-Through

Iran’s economy has always experienced double-digit inflation in recent years, which has been analyzed from different angles (Ali Asghari, 2013). A main feature of most oil-exporting countries such as Iran is the dependence of the structure of their economy on oil revenues, leading these countries to be under the influence of economic prosperity or recession in the global economy (Mehrara and Mohaghegh, 2011). In Iran, like some of the oil-exporting countries, the influence of oil revenues on the economy is determined in light of the country’s fiscal policy. Moreover, a part of the oil revenues enter the economic cycle through expansionary monetary (selling the foreign exchange in the domestic market), highlighting the prime importance of oil revenues in these countries (Jalaee and Mohammadi, 2012). Another important factor is the increase of the value of the national currency in oil-exporting countries which is the result of injecting foreign exchange earnings from oil exports to the domestic foreign exchange market. On the other hand, the fall of the value of the national currency (due to negative oil shocks) would increase import prices (Farzanegan and Markwardt, 2011); therefore, the price of production inputs will build up, influencing production and domestic prices.

A part for these points, one of the features of oil revenues, or more precisely oil shocks, is that they are asymmetrical (Shirinbakhsh and Moghadasi Bayat, 2011). It is generally believed that negative oil shocks decrease the level of common economic activities and domestic production and increases inflation (Mehrara, 2008); however, positive shocks will not have a significant positive influence on employment and production. When oil revenues increase, a part of the effect of the injection of oil revenues is neutralized. This will raise the inflation level without enhancing production (Eltejaei and Arbab Afzali, 2012).

In order to account for these asymmetrical effects, we may argue that government spending goes up when oil revenues climb. In economies like Iran, government spending leads to the exclusion of private sector investors from the economic cycle, and this will decrease the positive effects of government spending (Kazemi and Kazemikhasragh, 2013). Conversely, when oil prices and exchange revenues fall, the decrease of government spending is not necessarily equivalent to the decrease of oil revenues because of the flexibility of government spending. The reason is that a significant decrease is not possible (Pahlavani et al, 2010). In this situation, the government's construction budget falls, affecting investment, production, employment, and inflation (Moshiri and Banihashem, 2011). Moreover, most projects will not be provided with enough funds to be finished and this leads to an economic inefficiency. Therefore, the effects of oil shocks are asymmetrical in Iran's economy, and it seems that the impacts of negative oil shocks on production and inflation are more detrimental in the long run in comparison with those of negative shocks.

3. Hidden Co-integration and CECM Model

Generally, the asymmetrical effects of an exogenous variable on an endogenous variable mean that the reaction of the dependent variable to a given amount of increase or decrease in the independent variable is not fixed (Honarvar, 2009). Various models have been proposed to model the asymmetrical relations between economic variables. One of these models that is able to model asymmetrical short-term, long-term, and dynamic relationships between the variables is CECM, which is going to be explained.

The Crouching Error Co-integration Model (CECM) which is based on hidden co-integration method was proposed by Granger and Yoon in 2002. They examined the co-integration between the negative and positive integrative combinations of the time series data using the CECM model. Based on this theory, if the combinations of the data related to two time series (positive and negative) have co-integration, these data have a hidden co-integrated relationship. Hidden co-integration is an example of nonlinear co-integration which cannot be examined using the commonly used tests of linear co-integration. The model is as follows:

Assume that x_t and y_t are two time series stochastic variables which have been defined as follows:

$$x_t = x_{t-1} + \varepsilon_t = x_o + \sum_{i=1}^{t} \varepsilon_i \qquad (1)$$

$$y_t = y_{t-1} + \eta_t = y_o + \sum_{i=1}^{t} \eta_i \qquad (2)$$

In which x_0 and y_0 are the primary values of x_t and y_t, ε_t and η_t are residual and the mean of these two variables are zero, and the co-integration vector of x_t and y_t is linear. When the changes of y_t and x_t are asymmetric, we can have a hidden co-integration between them with a nonlinear vector. Granger and Yoon (2002) defined positive and negative shocks in this equation as follows:

$$\begin{aligned} &\varepsilon_i^+ = Max(\varepsilon_i, o) \;,\; \varepsilon_i^- = \min(\varepsilon_i, o) \\ &\eta_i^+ = Max(\eta_i, 0) \;,\; \eta_i^- = Min(\eta_i, 0) \\ &\eta_i = \eta_i^+ + \eta_i^- \quad ,\; \varepsilon_i = \varepsilon_i^+ + \varepsilon_i^- \end{aligned} \qquad (3)$$

Thus:

$$\begin{aligned} x_t &= x_{t-1} + \varepsilon_t = x_o + \sum_{i=1}^{t} \varepsilon_i^+ + \sum_{i=1}^{t} \varepsilon_i^- \\ y_t &= y_{t-1} + \eta_t = y_o + \sum_{i=1}^{t} \eta_1^+ + \sum_{i=1}^{t} \eta_i^- \end{aligned} \qquad (4)$$

Therefore, based on the above formulas we will have:

$$\begin{aligned} x_t &= x_o + x_t^+ + x_t^- \\ y_t &= y_o + y_t^+ + y_t^- \end{aligned} \qquad (5)$$

Then:

$$\begin{aligned} &\Delta x_t^+ = \varepsilon_t^+ \quad , \quad \Delta x_t^- = \varepsilon_t^- \\ &\Delta y_t^+ = \eta_t^+ \quad , \quad \Delta y_t^- = \eta_t^- \end{aligned} \qquad (6)$$

There are estimations of the values of first-order differencing of both time series can be observed in the positive and negative changes, for example in $(\Delta x_t^+, \Delta x_t^-)$. The next step involves calculation of the changes of all the variable's positive and negative integrative combinations (e.g., $x_t^+ = \sum \Delta x_t^+, x_t^- = \sum \Delta x_t^-$). X and y have hidden co-integration when their combination is also co-integrated. It is possible to examine hidden co-integration among all the possible combinations of the positive and negative components of y_t and x_t.

CECM model is similar to standard ECM model except in analysis of the price changes with positive and negative components. Observing the standardized ECM if y_t and x_t are co-integrated, the ECM model can explain the exogenous asymmetry with a co-integration vector of (1,β).

$$\Delta y_t = \psi_0 + \psi_1(y_{t-1} - \beta x_{t-1}) + \sum_{i=1}^{k} \psi_{x_i} \Delta x_{t-i} + \sum_{j=1}^{p} \psi_{y_j} \Delta y_{t-j} + v_t$$
$$\Delta x_t = \gamma_o + \gamma_1(y_{t-1} - \beta x_{t-1}) + \sum_{i=1}^{k} \gamma_{xi} \Delta X_{t-i} + \sum_{j=1}^{p} \gamma_{y-j} \Delta y_{t-j} + \varepsilon_t \qquad (7)$$

4. Empirical Results

In this study, the monthly time-series data of oil price and consumer price index have been used. These data cover the period from March 2003 to March 2013 and have been extracted from the website of Central Bank of Iran. The abbreviations for the variables in this study are as follows:

LOIL	The Natural Logarithm of the Oil Price.
dLOIL	The Logarithmic Differential of the LOIL (The Oil-Price-Return Series).
$LOIL^-$	The Cumulative Aggregate of Negative Components of the LOIL.
$LOIL^+$	The Cumulative Aggregate of Positive Components of the LOIL.
LCPI	The Natural Logarithm of the Consumer Price Index.
dLCPI	The Logarithmic Differential of the LCPI (The Inflation Series).
$LCPI^-$	The Cumulative Aggregate of Negative Components of the LCPI.
$LCPI^+$	The Cumulative Aggregate of Positive Components of the LCPI.

4-1. Long-Term Relationship based on CECM Model

In order to avoid spurious regression, the stationary test of the variables of the study is examined. The results are shown in Table 1.

Table 1. The Results of the Stationary Test

Variable	*Status Check*	*ADF Statistic*	*Critical Value*		
			1%	*5%*	*10%*
LO	*I(1)*	*-25.27*	*-2.56*	*-1.94*	*-1.61*
LCPI	*I(2)*	*-23.66*	*-2.56*	*-1.94*	*-1.61*
LO^+	*I(1)*	*-6.25*	*-2.56*	*-1.94*	*-1.61*
LO^-	*I(1)*	*-9.51*	*-2.56*	*-1.94*	*-1.61*
$LCPI^+$	*I(1)*	*-6.17*	*-2.56*	*-1.94*	*-1.61*
$LCPI^-$	*I(2)*	*-5.02*	*-2.56*	*-1.94*	*-1.61*

Table 1 demonstrates that all of the variables are non-stationary. The oil price series and its negative and positive components and also the positive components of consumer price index are first-order-integrated and the consumer price index and its negative components are second-order-integrated. Therefore, the results of this table illustrate two basic points:

1. There is a possible asymmetrical relationship between oil price and consumer price index.

As shown in Table 1, the oil price series is first-order-integrated while the consumer price index is second-order-integrated. This suggests that there are no linear and symmetrical long-term and short-term relationships between these two variables.

2. There is possible asymmetrical co-integration between the components of the oil price and consumer price index.

The analyzed components of the oil price and consumer price index do not have a similar co-integration level because the negative components of consumer price index are second-order-integrated.

Therefore, the estimation of a short-term relationship between the oil price and consumer price index based on Ordinary Least Square (OLS) method is not correct unless the long-term relationship between these variables is confirmed with an identical integration level. This relationship will be tested through Engle-Granger two-stage test. In this test, a regression equation between non-stationary variables with similar integration level is estimated first, and then the stationariness of the residuals of the estimated equation is explored. If these residuals are stationary, there is a long-term relationship between these variables. The results of this test are depicted in the following table 2.

Table 2. The Results of the Engle-Granger Test

Variables	*Trace Criterion*	*Maximum eigenvalue Criterion*
$LCPI^+$, LO^+	*Have a Long run relationship*	*Have a Long run relationship*
$LCPI^+$, LO^-	*Have a Long run relationship*	*Have not a Long run relationship*

According to Table 2, only the residual of the regression equation between ($LOIL^+$ and $LCPI^+$) are stationary and the residuals of the regression equation of ($LOIL^-$ and $LCPI^-$) are non-stationary. Therefore, there is no long-term relationship between the oil price and consumer price index, but there exists a long-term relationship between their positive components. This indicates the asymmetrical relationship and hidden co-integration between these variables. Equation 8 illustrates this:

$$\begin{aligned}
&LCPI^+ = 0.186 + 0.947\,LOIL^+ \\
&T: \quad (15.104) \quad (33.102) \\
&R^2: 0.98 \quad F-Statistic: 6986.039 \qquad (8) \\
&prob(F-Statistic): 0.000 \\
&DW: 0.1139
\end{aligned}$$

Equation 8 demonstrates that the coefficient of the positive components of the oil price is positive and significant. Therefore, be long-term pass-through of the oil price into consumer price index is about 0.95. On the other hand, there is no long-term relationship between the negative components of these variables; hence there is an asymmetrical long-term relationship between the analyzed components of these variables. Consequently, there is an asymmetrical and hidden co-integration between the oil price and consumer price index. Based on F-Statistic and its probability level in Equation 8, we can argue that the estimated model is significant. Durbin-Watson statistic also confirmed that there is co-integration between the components of the estimated model. In order to solve this problem, the Newey-West (1987) fixed method has been used. The estimated relationship is a long-term one and entering the pauses of the dependent variable or the residual existing in short-term relationships is not permitted in this equation.

4-2. Dynamic CECM Model

Due to the fact that there is a long-term asymmetrical relationship between the positive components of consumer price index and oil price, in this section the modeling of dynamic CECM between the components of these series is examined and the results are shown in Equation 9.

$$\begin{aligned}
&dLCPIp = 0.001 + 0.76\,dLOILp - 0.145\,ECT(-1) - 0.27\,AR(1) \\
&T: \quad (1.852) \quad (17.154) \quad (-2.038) \quad (-3.149) \\
&R^2: 0.72 \quad , \quad DW: 1.75 \\
&prob(F-Statistic): 0.000 \quad , \quad F-Statistic: 1211.411 \qquad (9) \\
&ARCH\,Test\,prob: 0.166 \\
&McLeod-Li\,Test\,prob: 0.150 \\
&Ljung-Box\,Test\,prob: 0.283
\end{aligned}$$

The error correction model (ECM) in Equation 9 indicates that the changes of the positive components of inflation (*dLCP)* are a function of the long-term equilibrium relationship and the changes of exogenous variables. This model links the short-term and long-term behavior of the positive components of the inflation and the oil price through the balancing component of error correction. The ECT coefficient in this equation indicates that if a shock in the short run leads to the exclusion of the variables of the model from the long-term equilibrium, the impact of this shock will be evaded after around 7 periods. The coefficient of the positive components of the oil price equals 0.76, and this variable, like the long-term relationship indicates the short-run elasticity of the positive components of all products and services indicator towards the oil price changes or the pass-through of positive oil shocks into the price indicator.

The identification tests of this model attest to the correctness of its estimation *ARCH, McLeod-Li* and *Ljung-Box tests* examined the residuals of Equation 9. The results of these tests confirmed that there is no heteroskedasticity or autocorrelation between the residuals.

It should be noted that the coefficient of AR(1) is negative and significant in Equation 9, which has been happened in different studies ((Bottazzi et al. (2012); Nyberg (2011); Kerekes (2009); Egert (2009); Nymoen (2008); Perron and Qu (2007); Moneta and Ruffer (2006); Kaufmann (2003); Fisher (2001); Perron and NG (1998)). The possibility of a fractal process or existence of the long memory in the market (Lavancier et al, 2010), non-linear structures in the residuals (Ranaldo and Soderlind, 2009), and numerous changes in the series under investigation (Savva, 2009) are among the important reasons underlying the fact that the coefficient of AR is negative. Moreover, the probability of having a negative coefficient for AR is far greater when the range of the endogenous variable data is from -1 to +1 (Tang and Yuan, 2012).

5. Conclusion

In this research, the symmetrical pass-through of the oil price to inflation in Iran based on hidden co-integration approach investigated. The results of this study revealed that the short-term and long-term relationship between the positive components of consumer price index and oil price is non-liner. The estimation of this relationship has been modeled by CECM Model. In line with the long-term relationship, the results of the dynamic model also confirmed the positive and meaningful relationship between the oil price and inflation. Another important finding of this research is that the oil price in Iran passes through inflation in an asymmetrical way. The coefficient of the pass-through of the oil price to inflation in the long-term relationship is 0.95 and in the dynamic short-term relationship is 0.76. This means that the pass-through of the oil price to inflation in Iran is considerable.

The recent changes in the oil price in Iran in the beginning of 2013 are a clear instance of confirming these results, exerting a huge influence on inflation. Moreover, Iran’s economy have been greatly import-based in the recent years; therefore, any change in the oil market and hence the exchange market will have a profound effect on imported products price indicator and consequently inflation. Furthermore, Iran’s exchange revenues are mainly obtained through the exportation of oil, influencing inflation though monetary policies. Hence, those involved in domestic monetary policies should bear in mind the fact that implementing independent monetary policies regardless of the changes in the oil market is not possible and would deviate attempts from the desired results.

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