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An asymmetric analysis of the relationship between oil prices and output: The case of Turkey

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ABSTRACT

In this paper we analyze the asymmetric impact of oil price changes on the economic activity in Turkey. In contrast to previous studies on Turkey, the existence of an asymmetric relationship between economic activity and oil prices is investigated by regime-dependent impulse response functions and forecast error variance decompositions based on a multivariate two-regime Threshold VAR (TVAR) model. Our analysis suggests that the relationship between oil prices and macroeconomic activity is nonlinear and exhibits an asymmetric pattern: oil price changes have a significant effect on inflation and output when the change exceeds a certain threshold level. The lower response of macroeconomic variables to oil price shocks in the low oil price change regime also indicates that only the shocks exceeding the optimal threshold level are able to create a contraction in the economic activity.

1. Introduction

The two consecutive oil shocks and stagflation in the developed economies during the 1970s have attracted a great deal of attention in understanding the effects of oil price shocks on economic fluctuations. Hamilton (1983) found a negative and significant correlation between oil price increases and output, supporting the proposition that oil shocks have contributed to US recessions since the Second World War. After this influential work, the impacts of oil price shocks on macroeconomic variables have been investigated for various countries covering different periods (e.g., Bohi, 1991; Burbidge and Harrison, 1984; Gisser and Goodwin, 1986).

However, the oil price collapse around the mid-1980s did not lead to an expansion in economic activity, and this triggered a new debate on the existence of an asymmetric relationship between oil prices and output. If an asymmetric relationship really exists, oil price shocks should have a larger negative impact on output than oil price declines. Mork (1989) first examined the asymmetric response to oil price shocks by decomposing oil price changes into real price increases and decreases. Mork (1989) found that the negative correlation between oil prices and output is in fact not statistically significant when the sample size of Hamilton's model is extended to include the oil collapse in 1986. Once oil price increases and decreases are estimated separately, coefficients for oil price increases become significant and negative. However, the results do not indicate any evidence for significant effects of oil price decreases. Mork et al. (1994) also confirmed the validity of a similar type of asymmetric behavior for the OECD countries. Their results revealed that oil price increases seemed to have a negative impact on economic growth in the USA to a larger extent, although the USA does not depend on imported oil compared to other developed countries, such as Germany, France, and Japan.

Some authors also have estimated models with alternative transformations of oil price increases based on the view that only persistent oil price increases are able to create a contractionary effect on economic activity. Hamilton (1996) proposed a Net Oil Price Increase (NOPI) variable based on the difference between the current price and the maximum price over the previous year. This variable considers only the changes exceeding the maximum value; the oil price changes falling below the critical value are assumed to have no effect on economic activity. Lee et al. (1995) argued that oil price volatility should also be included in order to capture the effects of unexpected oil price increases. Hence, they constructed a volatility-adjusted measure Scaled Oil Price Increases (SOPI) variable based on the estimation of the univariate GARCH model of oil price change. Lee et al. (1995) found that oil price movements were likely to be more important in an environment with historically stable prices, whereas the impact of oil shocks would have less impact when prices were relatively volatile.

Although the asymmetry in the relationship is well documented in the literature, a limited number of studies have attempted to measure that relationship using nonlinear models. Sadorsky (1999) was the first who attempted to model the oil price and macroeconomy relation using a two-regime Threshold VAR model. Using U.S. data compromised

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of oil prices and output, stock returns, and interest rates, Sadorsky (1999) found that oil price increases had a greater impact on economic activities and could better explain the evolution of macroeconomic variables than interest rates. Impulse response and variance decompositions also verified that oil price decreases did not have a significant effect on the economy. This confirmed the existence of a nonlinear relationship between oil prices and macroeconomic variables. Huang et al. (2005) improved the model of Sadorsky (1999) in that their estimates were based on a multivariate threshold model where the transition between regimes was determined by the optimal threshold level of oil price changes estimated by the model. Using the monthly data of the US, Canada, and Japan covering the period 1970–2002, they found that the optimal threshold level of oil price changes varied across the countries according to their degree of oil dependence. Their results also confirmed the asymmetric behavior of oil prices: oil price changes had a limited impact on the economy if the change fell below the threshold levels. However when the change exceeded a certain threshold level, oil prices could better explain macroeconomic variables than oil price volatility and real interest rates. Rahman and Serletis (2010) also investigated the asymmetric impacts of oil price shocks on economic activity using a logistic smooth transition VAR model for monthly US data covering the period 1983:1 to 2008:12. Their results suggested that oil prices and oil price volatility had an impact on economic activity and that monetary policy also contributed to the asymmetric response of output to oil price shocks.

Regarding the Turkish literature, relatively few studies have analyzed the relationship between oil prices and economic activity.[1] We have found only two studies: Alper and Torul (2008) and Torul and Alper (2010) which obtained mixed results regarding the existence of contractionary impacts of oil shocks in Turkey. Using a linear VAR model compromised of different versions of asymmetric oil price increase variables and Gross Domestic Product (GDP), Alper and Torul (2008) found that the negative responses of output to oil price changes had significantly declined since the early 2000s. Torul and Alper (2010) used a similar model as Alper and Torul (2008). However, they did not report any significant evidence regarding negative effects of oil price shocks on the aggregate industrial production. The mixed results from these studies might be attributable to ignorance of the nonlinearity in the relationship. The existence of asymmetric effects was not statistically validated. Rather, the asymmetry was introduced in an ad-hoc manner with the inclusion of various oil price increase variables.

Therefore, although the asymmetric relationship between oil prices and economic activity is well documented in the literature, to the best of our knowledge, there is no study analyzing the existence of such a relationship for Turkey by using nonlinear models. An analysis of the asymmetric effect of oil prices on economic activity has important implications for two reasons in Turkey. First, Turkey is highly reliant on imported oil with 95% of oil demand supplied by imports (EMRA, 2010). According to the data released by the Turkish Statistical Institute (TURKSTAT), the import of crude oil in 2010 increased by 18.7% compared to the previous year. The total amount of imported crude oil in 2010 accounted for more than 5% of total imports. Second, our investigation period incorporates important financial crisis and turbulent periods in terms of output and oil price movements. Given these issues, one can argue that the impact of oil prices on macroeconomic activity may not be properly captured by linear estimates.

This paper contributes to the empirical literature in three respects. First, the nonlinearity and the existence of the optimal threshold value of oil price changes is examined through a multivariate threshold vector autoregressive model, as proposed by Tsay (1998). Second, using this model we conduct regime-dependent impulse response functions and forecast error variance decompositions to account for the asymmetric response of economic activity to oil price shocks as in Huang et al. (2005). Third, the existence of the asymmetric relationship is also investigated at the disaggregated level by using the output of heavily oil dependent manufacturing industries. Our analysis provides empirical support for the asymmetric impact of oil price shocks in Turkey.

The remainder of the paper is structured as follows. The data are introduced in Section 2. Section 3 explains the structure of the linear and TVAR models employed in the estimates. The empirical findings are presented in Section 4. Finally, the paper ends with conclusions and policy proposals.

2. Data

In this study we use monthly data for the period 1988:1 to 2011:3. As a measure of economic activity we use the log of Gross Domestic Product $lgdp_t$. Since GDP figures are not available on a monthly basis, the monthly GDP is interpolated through the monthly industrial production index using the method introduced in Friedman (1962).[2] As for the oil prices, we use the log of imported oil prices in terms of Turkish Lira $lroil_t$ deflated by wholesale prices. The data for output and real oil prices are presented in Fig. 1 in terms of first log-difference form. Since imported oil prices are also affected by exchange rate movements, we also include the log of nominal US/TL exchange rates denoted as $lner_t$ in the vector of endogenous variables. The interbank rate $inrate_t$ is also considered as one of the endogenous variables to analyze the response of the central bank to oil price shocks. As a proxy for the general price level we use the log of the Wholesale Price Index (WPI) with 1987 = 100 base year denoted as $lwpi_t$. Additionally, following Peersman and Smets (2003) we consider some exogenous variables, the federal funds rate ffr_t and the log of US industrial production index $lindus_t$, in order to account for the effects of international events on the macroeconomic activity. The data for imported crude oil prices come from the Turkish Ministry of Development; the other data are collected from the International Financial Statistics (IFS) Database of International Monetary Fund (IMF).

3. Methodology

In order to investigate the relationship between oil prices and economic activity in Turkey we consider the following VECM model,

$$\Delta X_t = \delta + \Pi X_{t-i} + \sum_{i=1}^{p} \Gamma_i \Delta X_{t-i} + \sum_{i=1}^{q} B_i \Delta Z_{t-i} + \theta Dcr_t + \varepsilon_t, \tag{1}$$

where X_t represents the vector of endogenous variables, $X_t' = [lroil_t\ lner_t\ intrate_t\ lwpi_t\ lgdp_t]$. Vector Z_t contains the exogenous variables, i.e. U.S. federal funds rate and industrial production, $Z_t' = [ffr_t\ lindus_t]$. We also introduce a dummy variable, denoted as Dcr_t, to uncover the possible impacts of crises in Turkey.[3] $\Pi = \alpha\beta'$ represents the impact matrix containing the vector of adjustment coefficients α and the vector of cointegration relations β. δ and θ are the respective parameters of constant and the crisis dummy variable. B is the parameter matrix for the vector of exogenous variables. p and q represent the lag orders of endogenous and exogenous variables. ε_t contains the vector of innovations $\varepsilon_t' = \left[\varepsilon_{oil}\varepsilon_{er}\varepsilon_{\text{int}}\varepsilon_{wpi}\varepsilon_{gdp}\right]$ with the variance covariance matrix of $E(\varepsilon_t\varepsilon_t') = \Sigma$.

[1] There is a relatively larger literature on the impacts of oil prices on inflation for Turkey. See, for example, Kibritcioğlu (2003), Berument and Taşçı (2002), Diboğlu and Kibritçioğlu (2004), and Çatık and Önder (2011).

[2] The interpolation of GDP into monthly frequency using industrial production index may lead to exclusion of valuable information and measurement errors in the estimates. In order to check the robustness of the results obtained with interpolated GDP, the models are re-estimated with total industrial production index. As shown in Fig. 4 the results suggest the existence of a similar type of asymmetry.

[3] To detect a common structural break point in the VAR model we applied the tests developed by Bai et al. (1998). The Sup-W and Exp-W tests suggest the existence of a break in the earlier periods of 2002. 90% confidence intervals obtained through the common break tests cover the similar period of 2001:10–2002:08. Therefore, this interval is used in the construction of crisis dummy variable.