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The Effects of Oil Shocks on Turkish Macroeconomic Aggregates

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ABSTRACT

This paper examines the impacts of oil price shocks on macroeconomic aggregates of Turkey. We find evidence suggesting the influential role of oil price shocks on macroeconomic aggregates. In other words, we find that oil price shocks affect output growth negatively with a delay. However, higher oil prices are associated with higher inflation, and depreciating exchange rate. We also explore the role of asymmetric oil shocks on macroeconomic aggregates and find that both oil price increases and decreases are associated with a delayed lower output growth rate. Furthermore, we find oil price increases affect inflation positively with a delay. The appreciation of exchange rate appears with a delay due to oil price decreases.

Keywords: Oil Price Shocks, Economic Activity, Turkey
JEL Classifications: C22, C32, Q43

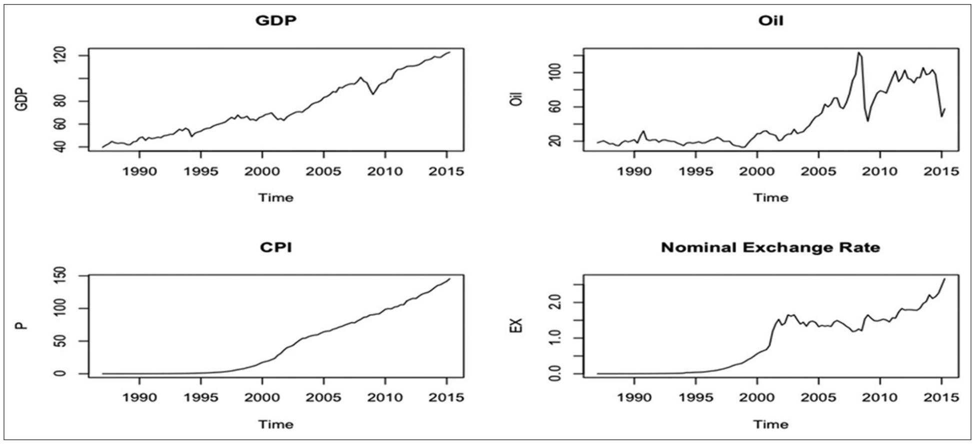
1. INTRODUCTION

Since the first oil price shock in 1973, economists pay more attention in examining the consequences of oil price fluctuations on the global economies because of the fact that oil has been the major resource for the manufacturing industries. This attention was first embodied with Hamilton's (1983) seminal work investigating the impacts of oil price shocks on the US economy since World War II. Hamilton (1983) not only finds evidence supporting the negative relationship between oil price increases and US economic activities, but also documents that oil price shocks are the main cause of seven out of eight of the U.S. postwar recessions. Mork (1989) extends the work of Hamilton (1983) and confirms the negative relationship between economic growth and oil price shock. Moreover, Mork (1989) finds evidence indicating oil price increases are associated with the decline of the US output growth, whereas the declines of oil prices do not promote economic growth. On the other hand, Hooker (1996) reexamines the results of Hamilton (1983) and documents that Hamilton's results hold over the period 1948-1973, but not when he extends the sample over 1989.

However, other economists, including Hooker (1996), criticize the work of Hamilton (1983) because it relies on the assumption of linearity of oil prices. Therefore, several linear and nonlinear measures of oil price shocks have been proposed (Hamilton, 2003 for further discussion). Thus, with the development of various measures of oil prices, there is a large share of the literature looking into the consequences of changing oil prices on economic growth (e.g., Hamilton, 1996; Kilian, 2008a), inflation (e.g., Chen, 2009; Bachmeier and Cha, 2011), exchange rates (e.g., Amano and van Norden 1998), financial markets (e.g., Kilian and Park, 2009), employment (e.g., Davis and Haltiwanger, 2001), terms of trade (e.g., Backus and Crucini, 2000), and various economic and financial activities; Kilian (2008b) and Segal (2011) provide for a comprehensive literature review regarding the impacts of oil shocks on different economic and financial activities.

Despite the fact that Turkey depends heavily on imported crude oil, there are a limited number of studies linking oil prices on Turkish macro and financial variables. Additionally, existing literature assessing the impacts of oil price shocks on the Turkish economy documents mixed results. For instance, Berument and Tasci (2002) analyze the effects of oil prices on inflation based on the 1990 input-output table. They document that under fixed nominal wages, profits, and interest and rent earnings, higher oil prices that lead to inflation are marginal. However, in their analysis under the adjusted nominal wages, profits, interest rates and rent earnings, they provide evidence for oil price increases resulting in significant inflationary effects.

Figure 1: Macroeconomic aggregates and oil price



Alper and Torul (2008) investigate the consequences of higher oil prices on aggregate economic activity of Turkey and conclude the insignificant impact of rising oil prices on Turkish economic activity. Aydin and Acar (2011) analyze the impact of oil price shocks on Turkish economic growth through a dynamic computed general equilibrium model. The results indicate that doubling oil price leads to a decline of the Turkish output by 14%.

Likewise, Eryigit (2012) investigates the consequences of oil prices on the Turkish exchange rate, interest rate and the main index of Istanbul stock market Exchange rate using weekly data from January 2005 to October 2008. Their analysis indicates that oil price shocks have positive impacts on stock market and negative impacts on both interest rates and exchange rates.

Gökçe (2013) also probes the impact of oil price volatility on Turkish economic growth with quarterly data spanning from 1987:Q1 to 2011:Q4. The finding of this study indicates the significant impacts of oil price volatility on Turkish economic growth; in particular, the impulse response analysis indicates the positive response of output growth to oil price increases.

A recent work of Ozturk (2015) examines the effects of oil price shocks on various Turkish macroeconomic variables using quarterly data over the period 1990:Q1 and 2011:Q4. The impulse response analysis conducted in the study reveals that oil price shocks had significant impacts on macroeconomic variables during that period of time in Turkey. In particular, he finds evidence for the negative impacts of positive oil price shocks on industrial production, money supply, and imports with two quarters lag; however, these shocks had immediate positive impacts on inflation rate. On the other hand, he finds insignificant impacts of negative oil price shocks on all variables except imports.

The main objective of this paper is to investigate the consequences of oil price shocks on the Turkish economy. Therefore, this paper aims to contribute to the existing literature in two ways. First, to fill out the gap in the literature that is examining the consequences of oil price shocks on Turkish economic activities. Second, we distinguish between the asymmetric effects of oil price shocks on the Turkish economy.

2. DATA

The dataset consists of quarterly observations starting from 1987:Q1 to 2015:Q2 for real gross domestic product (GDP), consumer price index (CPI), and nominal exchange rates (national currency per US dollar), and West Texas intermediate crude oil price. The data for GDP, CPI, and oil price are retrieved from the International Financial Statistics database of the International Monetary Fund while exchange rate data are obtained from the database of the Organization for Economic Co-operation and Development. Figure 1 shows the plotted series of oil prices, CPI, and Exchange rates. It is also worthy to note that we apply the Census X-13 procedure[1] to adjust for seasonality in GDP data.

3. METHODOLOGY

3.1. Preliminary Investigation

The first step in our analysis is to ensure the stochastic properties of the economic variables we consider. To do so, we rely on the standard unit root tests, such as augmented-Dickey Fuller (1979) and Phillips and Perron (1988), to test the null hypothesis of no unit root against the alternative of the presence of unit root in the data. The results of unit root tests, presented in Tables 1 and 2, confirm the non-stationarity of the data in their levels; however, the variables become stationary when the first difference of the data is taken.

Since the economic variables are integrated of the order one, we are required to examine the possible existence of the cointegration relationship between these variables as suggested by Engle and Granger (1987). For the examination of the cointegration, we rely on the most common tests of multiple cointegration relationships developed by Johansen and Juselius (1990). Table 3 summarizes the results of both Trace and eigenvalue tests of Johansen and Juselius (1990). Test results suggest the existence of three-cointegration relationships between the selected economic variables. It is also worth to note that the cointegration tests' results also led us to determine the appropriate model in order to examine the consequences of oil price shocks on economic variables. In

1 More information can be found on the US Census website: https://www.census.gov/srd/www/x13as/.

Table 1: Augmented Dickey-Fuller (1979) unit root test

Variables	Level data			Differenced data		
	Drift	Trend	None	Drift	Trend	None
Oil price	−1.9696	−3.8975	−0.8325	−9.1105	−9.0676	−9.0826
GDP	−0.3864	−3.411	3.5265	−7.7266	−7.6912	−6.6546
CPI	−4.8323	0.4803	−0.1723	−2.4336	−5.1605	−1.517
EX	−3.0124	−0.3705	−4.407	−6.2779	−7.3272	−4.7469

The critical values at 0.05 significance levels are−2.88 for drift, −3.43 for trend, and−1.95 for none. GDP: Gross domestic product, CPI: Consumer price index

Table 2: Phillips and Perron (1981) unit root test

Variables	Level data		Differenced data	
	Constant	Trend	Constant	Trend
Oil price	−1.2451	−2.5601	−8.5805	−8.531
GDP	−0.5641	−3.6633	−11.0942	−11.0401
CPI	−5.9291	0.6614	−4.1504	−7.9206
EX	−2.9857	−0.2124	−8.649	−9.3777

The critical values at 0.05 significance levels are−2.88 for constant and−3.45 for trend. GDP: Gross domestic product, CPI: Consumer price index

other words, in this study, we have conducted a structural vector error correction (SVEC) model instead of a vector autoregressive (VAR) model to analyze the impact of oil price shocks on selected economic variables.

3.2. The Benchmark Model

The VAR models are the standard modeling frameworks examining the consequences of oil price shocks on various macroeconomic and financial variables using both aggregate and disaggregate data. Therefore, several studies employ the VAR models in order to analyze the impacts of oil price shocks on various economic and financial variables for both developed and developing countries. However, in case there exists a cointegration relationship, then it is more appropriate to relay on the vector error correction (VEC) models rather than VAR models[2] to examine the consequences of oil price shocks.

Hence, for the main objective of this paper, we carry out our analysis based on the VEC model since we find evidence of cointegration among the economic variables. To do so, the starting point of our analysis is to estimate the reduced VAR (p) model as follows:

$$y_t=A_1y_{t-1}+A_2y_{t-2}+\ldots+A_p\, y_{t-p}+u_t \quad (1)$$

Where y_t is a (n × 1) vector of endogenous variables and contains the price of oil, GDP, CPI, and nominal exchange rate as given order. Ai's are the coefficient matrices with (n × n) dimension, and u_t is a (n × 1) vector of white noise process. It is also worth to note that the lag length p is determined based on the Akaike information criteria.

By assuming that all variables are at most difference stationary, then the reduced VAR (p) model can be written as a SVEC model of the form:

2 Hamilton (1994) points out that some economists prefer VAR models even when there exists a cointegration among economic variables while other economists prefer VEC models. For further discussion regarding this issue see Hamilton (1994) p.651-653.

$$B_0\Delta y_t = \Pi^* y_{t-1} + \Gamma_1^*\Delta y_{t-1} + \ldots + \Gamma_{(p-1)}^*\Delta y_{t-p+1} + \varepsilon_t \quad (2)$$

Where Δ denotes the first difference operator, Γ*'s are the matrix of short run coefficients with a (n × n) dimension, Π* is the (n × 1) structural matrix, and ε_t is the (n × 1) structural error vector with zero mean and a covariance matrix I_K. The B_0 matrix, which has (n × n) dimension, contains the contemporaneous relations among all variables in y_t.

To obtain the reduced form VEC model, we assume the invertibility of B_0, so that Equation (2) can be written as:

$$\Delta y_t=\Pi y_{t-1}+\Gamma_1\Delta y_{t-1}+\ldots+\Gamma_p\Delta y_{t-p}+u_t \quad (3)$$

Where

$\Pi = B_0^{-1}\Pi^*$ and $\Gamma_j = B_0^{-1}\Gamma^*$ for j=1, 2,…, p−1, and $u_t = B_0^{(-1)}\varepsilon_t$ linking reduced form errors u_t' to the underlying structural errors ε_t.

It is also important to note that when has a reduced rank of r≤n-1, then we can write Π as Π=αβ', in which α and β are the full rank matrices of loading factors and long-run coefficients with the same dimensions of (n × r) respectively.

Since the reduced form errors u_t' are strongly correlated, then it is expected to face difficulty to eliminate the impact of a single shock on the whole system. However, to eliminate this effect, we need to impose some restrictions on the system.

Since the reduced form error is given as:

$$u_t = B_0^{-1}\varepsilon_t \quad (4)$$

And multiply both sides by B_0 in order to get,

$$B_0 u_t = \varepsilon_t \quad (5)$$

$$\Sigma = B_0^{-1}\Sigma_\varepsilon (B_0)' \quad (6)$$

Where Σ and Σε are (n × n) covariance matrices. In order to identify the structural shocks, we relay on the Cholesky recursive identification procedure. To do so, we order the endogenous variables in the VEC model as the price of oil, GDP, CPI, and nominal exchange rate as given order.

The assumptions of the variables order are as follows. First, the price of oil takes the first order because the price of crude oil is determined in oil market, so it is not impacted contemporaneously by other variables. Second, the real GDP does respond to changes in oil price while does not respond to changes in consumer prices and exchange rate. Third, consumer prices respond to changes in oil markets and real GDP but not to changes in nominal exchange rate. Lastly, the nominal exchange rate captures all changes in oil market, real GDP, and consumer prices.

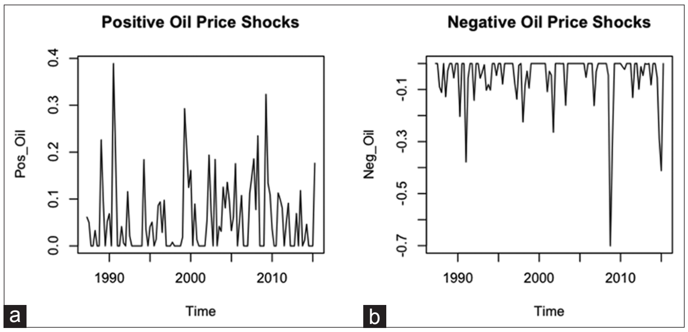
Once we estimate the SVEC model, we relay on the impulse response function in order to interpret the results rather than

Table 3: Johansen and Juselius (1990) cointegration tests

H_0	Eigen value test				Trace test			
	r=0	r≤1	r≤2	r≤3	r=0	r≤1	r≤2	r≤3
Test-statistics	122.23**	57.89**	27.28**	3.50	210.90**	88.67**	30.78**	3.50

**Indicates the rejection of the null hypothesis at 5% significance level

Figure 2: The asymmetric oil price measures. (a) Positive oil price shocks, (b) negative oil price shocks



interpreting the parameter estimates of the SVEC model as suggested by Sims (1980). Impulse response functions enable us to tackle the time path of oil price shocks on other variables included in the SVEC model.

3.3. Threshold Model

The literature proposed several linear and nonlinear measures of oil price shocks attempting to understand the macro and financial effects of oil price shocks; some of which only nonlinear transformation of oil prices. One of the most common measures is the threshold model proposed by Mork (1989) accounting for positive and negative oil price shocks which has been employed in various studies.

Therefore, we aim to examine how Turkish economy react to positive oil price shocks as well as negative oil price shocks. To do so, we need to determine the asymmetric specification distinguishing between positive oil price shocks and negative oil price shocks can be defined as follows:

$$Oil_t^+ = \begin{cases} O_t \text{ if } \Delta O_t > 0 \\ 0 \text{ otherwise} \end{cases} \quad (7)$$

And

$$Oil_t^- = \begin{cases} O_t \text{ if } \Delta O_t < 0 \\ 0 \text{ otherwise} \end{cases} \quad (8)$$

Where Oil_t^+ denotes the positive oil price shocks while Oil_t^- denotes the positive oil price shocks, as shown in Figure 2, and ΔO_t represents the percent change of oil price.

Next, we re-estimate the SVEC model with new measures of oil prices in order to understand the dynamic response of macroeconomic variables to asymmetric oil price shocks.

3.4. Impulse Response Function Analysis

Figure 3 presents the plotted impulse response function with 95% confidence intervals obtained based on a wild bootstrap with 1,000 replications.

First column of Figure 3 displays the response of macro variables to oil price shocks based on the benchmark model. Evidently, the immediate response of GDP to one-standard deviation shock to the real price of oil is positive only in the first quarter, but since the second quarter the GDP growth starts to decline until reach a stable level over the remaining time period. Likewise, we find that oil price shocks are associated with higher consumer prices that accelerate over time due to oil price shocks. On the other hand, we find changes in oil prices lead to the depreciation of the Turkish nominal exchange rate even though the nominal exchange rate tends to fluctuate over time period.

The second and third columns of Figure 3 illustrate the impulse responses of macro variables to asymmetric oil price shocks. In particular, the second column shows the responses of macro aggregates to positive oil price shocks and indicates that the positive response of GDP to positive oil price shocks only during the first quarter. In other words, we find the GDP growth declining from the second quarter until the remaining time horizon.

The impact of positive oil price shocks on consumer prices and nominal exchange rate is negative. The plotted impulses show that consumer prices decline during the first quarter then starts to increase over the time period. Likewise, nominal exchange rate depreciates as a result of positive oil shocks until reaching a stable level.

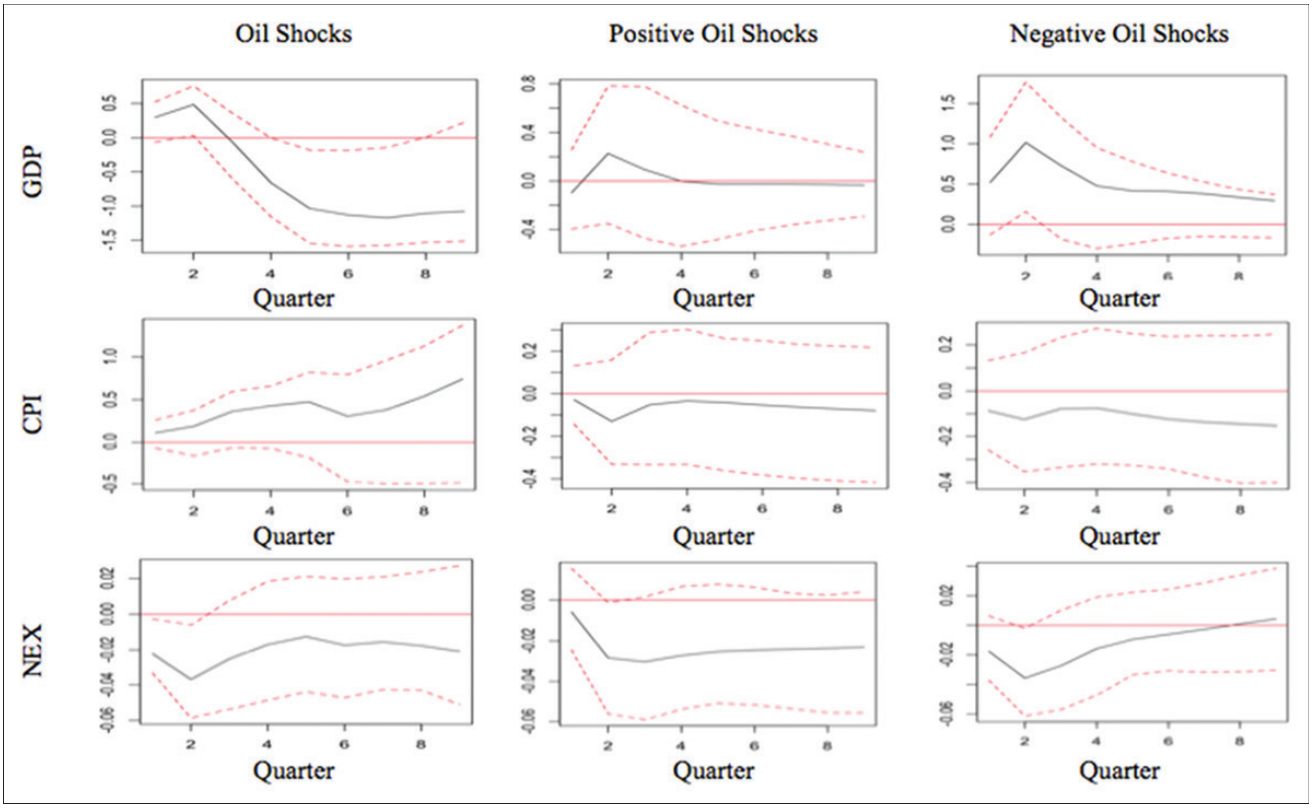
The plotted impulses in the third column of Figure 3 illustrate the response of macroeconomic aggregates to negative oil price shocks. In other words, we find that the negative oil price shocks are associated with higher output growth during the first quarter. However, even thought the GDP growth starts declining after the second quarter, it is still positive rate over the remaining time horizon.

Likewise, we find that negative oil price shocks cause the consumer prices to decline whereas the nominal exchange rate responds negatively until the second quarter when it starts to appreciate and continue appreciating until the rest of time period.

It is worth noting that the response of GDP growth to oil shocks is expected to be negative since Turkey depends heavily on imported oil; however, we find the immediate response of GDP growth to oil shocks to be positive then turns to be negative from the second quarter till the end of time horizon. This might be due to the delayed effect of oil shocks. In other words, Hamilton and Herrera (2004) argue that the effect of oil price shocks do not appear until the third or fourth quarter after the oil shock.

It is also important to note that our results are consistent with the findings of Berument and Tasci (2002), Aydin and Acar (2011), Gökçe (2013), and Ozturk (2015).

Figure 3: The dynamic response of macro aggregates to oil price shocks



4. CONCLUSION

This paper investigates the consequences of oil price shocks on macroeconomic aggregates; namely: Output, consumer prices, and exchange rate. We find evidence suggesting that oil price shocks impact output growth with a delay. On the other hand, we find higher oil prices are associated with rising consumer prices whereas oil prices are associated with depreciation of exchange rate.

We also distinguish between oil price increases and decreases and explore the response of macroeconomic aggregates to asymmetric oil price shocks. The results indicate that oil price increases affect output growth and consumer prices with a delay; in other words, we find oil price increases and decreases lead to the decline of output growth and the rise of consumer prices after the second quarter. On the other hand, we find oil price increases impact exchange rate negatively whereas oil price decreases impact exchange rate positively with a delay.

Understanding the consequences of oil price shocks on macroeconomic aggregates is useful for policy makers in order to maintain stable economy and stable inflation rate. To mitigate the negative impacts of oil price shocks, monetary policymakers may increase or decrease interest rate to maintain a target inflation rate. Likewise, policymakers may consider deregulating oil market in which results in setting oil price freely. This in turn indicates that oil price fluctuations would pass to consumers in a deregulated oil market price.

For future research, it is worth to examine the consequences of oil price shocks on investment, saving, employment, trade, balance of payments, and financial markets. Likewise, it would be interesting to examine the consequences of oil supply and demand shocks on the economy of Turkish.

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