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IMPACT OF OIL PRICE SHOCKS ON MACROECONOMIC VARIABLES: EVIDENCE FROM AN EMERGING MARKET

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Abstract: *The relationship between oil price shocks and macroeconomic factors has attracted substantial emprical research in both developed and developing countries. This study investigates impact of linear and various non-linear specifications of oil price shocks on chosen macroeconomic variables (GDP, inflation, net exports and real exchange rate) for an oil importing and developing country-Turkey. The study uses of quarterly data for Turkey over the period 1974:Q1 to 2013:Q1. The results of study indicate that oil price shocks have a significant impact on GDP, inflation and net exports in Turkey. The results of the Granger- causality test, variance decomposition analysis and impulse response functions all showed that different measures of linear and positive oil shocks have not caused the real exchange rate. Positive oil shocks have a more pronounced effect on macroeconomic variables than negative shocks. The tests support the existence of asymmetric effects of oil price shocks because this paper finds that negative oil shocks significantly cause GDP.*

Key words*: Oil shocks, macroeconomics variables, Granger-causality test.*

INTRODUCTION

Turkey that domestic market is oil import country is a rapidly developing country and the largest national economy in Central and Eastern Europe. Also, Turkey has recovered fast from the global financial crisis. However, In 2012, Turkish economy grew by 2.2%. Annual inflation in 2012 realized as 6.16%. Turkish economy have also boosted foreign trade, while exports reached USD 153 billion by the end of 2012. Moreover, Turkey is the 16th largest economy of the world and 6th largest economy compared with EU countries with a GDP of 786 billion USD in 2012. In the past years, the Turkish and World economies witnessed several oil shocks. The first oil shock occurred in 1973 afterwards 1979 and 1990, oil shock took place. Over the last years, the oil prices have become more volatile and have increased due mainly to higher costs of production, limited spare oil production capacity and increasing demand particularly from emerging economies.

The relationship between oil prices and macroeconomic factors has attracted substantial empirical research in both developed and developing countries. The

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past decades a large number of research has been developed by academics on the role, significance and relations of crude oil prices in the macroeconomy. This study investigates the effects of oil price changes on Turkey's macroeconomic variables such as GDP, inflation, real exchange rate and net exports.

Oil price shocks have been measured by authors in different methods. Firstly, Darby (1982) made international comparisons of oil shock impacts within a VAR framework and found for the U.S. that the estimated oil shock effect was much reduced if price controls during the 1970's were taken into account. Darby (1982) estimated the impact of the 1973-74 oil price shock on real income in eight OECD countries. He was unsatisfied with the ability of the available data to distinguish among threefactors that may have contributed to the recession: the oil price shocks; a largely independent course of monetary policy fighting inflation in the wake of the 1973 collapse of the Bretton Woods system; and a partly statisticalpartly real effect of the imposition and subsequent elimination of price controls over the period 1971-75.

On the other hand, Burbidge and Harrison (1984) analyzed vector autoregressions (VARs) to examine the impact of oil price shocks over the 1962-82 period for five advanced economies. They conclude that these shocks played a large role in deepening the recessions of the 1970s, with the impact on the 1973-74 recession much greater than that of 1979-80. They also find that the 1979-1980 oil shocks had a minimal effect on all these countries except Japan.

One of important studies is Hamilton (1983) that analyzed the correlation between oil prices and the output of the US economy over 1948-1972, and 1973-1980 in period. He concluded that changes in oil price appeared to Granger-cause both real and nominal GNP and unemployment. His results showed that oil price change had a strong causal and negative correlation with real U.S GNP growth from 1948 to 1980. Further work by Hamilton (1988, 1996, 2008) confirmed his conviction that statistically significant correlations existed between oil prices and macroeconomic activities. Mork's (1989) found that the real effects of oil price increases are different from those of decreases. Oil price decreases did not have a statistically significant impact on US economic activity. While, Lee et al. (1995) examined that the effects of oil price shocks are asymmetric. They reported positive oil price shocks tend to have a larger effect on GNP.

Oil prices can be shown to influence macroeconomic indicators by examining the effects of oil prices in GDP, industrial production and inflation (Darby, 1982; Hamilton, 1983; Burbridge and Harrison, 1984; Gisser and Goodwin, 1986; Mork, 1989; Jones *et al.*, 2004; Hanabusa 2009; Du *et al.* 2010; Korhonen and Ledyaeva, 2010).

Many studies have attempted to examine the relationship oil prices and macroeconomic variables and these include studies by such as, Hooker (1996)

demonstrated for the period 1948-72 that the oil price level and its changes do exert influence on GDP growth. He found that oil prices no longer Granger cause many U.S. macroeconomic indicator variables in data after 1973. In another study, Gisser and Goodwin (1986) found that oil price shocks affect macro economic variables (real GNP, price level, real invesment, unemployment rate) in USA between 1961 and 1982, they examine whether oil shocks have a different impact on the macro economy before 1973 than after. The impact of oil price shocks in the United States economy did not change much after 1973.

Lardic and Mignon (2006) investigated the existence of a long-term relationship between oil prices and GDP in 12 European countries. (Austria, Belgium, Finland, France, Germany, Italy, The Netherlands, Norway, Portugal, Spain, Sweden and the United Kingdom) using quarterly data from 1970:1 to 2003:4. They reported that there is an asymmetric cointegration. between oil prices and GDP in most European countries. A further their research (2008) they found evidence for asymmetric cointegration between oil prices and GDP indicating that rising oil prices seem to retard aggregate economic activity further than falling oil prices stimulate it.

Moreover, Rodriguez (2008) assessed the dynamic effect of oil price shocks on the output of the main manufacturing industries in six OECD countries (France, Germany, Italy, Spain, US and UK) It is found that the impact of an oil price shock on aggregate manufacturing output is negative in all countries and the largest (negative) impacts tend to be in the Anglo-Saxon countries. (Huson and Wadud 2011; Oladosu, 2009 ;Chang and Wong 2003).

Using vector autoregressive (VAR) Lorde et al (2009) methodology, investigated the macroeconomic effects (gross development product (output), government revenue, government consumption, gross investment, net exports and the price level) of oil price fluctuations on Trinidad and Tobago. He searched out that the price of oil is a major determinant of economic activity of the country. Moreover, gross investment, government consumption, government revenue and the average price-level rise following an oil price shock.

In some countries, oil prices affected the exchange rates (Narayan *et al.* 2008; Chai *et al.* 2011; Iwayemi and Fowowe, 2011). In addition to that, some studies have connected with oil prices and stock, consistent with this conclusion, they found that a negative relationship between oil prices and stock market returns. (Jones and Kaul, 1996; Filis (2010), Basher *et al.* 2011). In studies conducted for the Turkey, Lise and Monthford (2007) investigated linkage between energy consumption and GDP by undertaking an error correction model (ECM) for Turkey with annual data over the period 1970-2003. They showed that causality runs uni-directionally from GDP to energy consumption. In another study, Özlale and Pekkurnaz (2010) analysed monthly data from September 1999 to September 2008. They determined oil prices as a significant determinant of current account balances

for the Turkish economy. Besides, Aydın and Acar (2011) considered the impact of oil price shocks on the Macroeconomic factors in the Turkish economy (price shocks on macroeconomic variables of interest, including GDP, consumer price inflation, indirect tax revenues, trade balance, and carbon emissions) They implied that these oil prices have very significant effects on macro indicators and carbon emissions in the Turkish economy.

I follow Bachmeier (2008) in employing a linear specification as a benchmark and 3 different nonlinear functional forms to evaluate the impact of oil shocks on the economy. The nonlinear functional forms are the asymmetric functional form of Mork (1989), the net oil price increase of Hamilton (1996). Iwayemi and Fowowe (2011) have applied this model.

Such non-linear transformations are the following: (1) asymmetric specification, in which increases and decreases in the price of oil are considered as separate variables; (2) scaled specification (Lee *et al*., 1995), which takes the volatility of oil prices into account; and (3) net specification (Hamilton, 1996).

Following this introductory section, Section 2 describes the data and methodology for analysis. Section 3 presents the empirical results and last section provides concluding comments.

2. DATA AND METODOLOGY

2.1. Data

The study determines the impact of oil price shocks on real gross domestic product (GDP), inflation (INF), net exports (EXPORT) and real exchange rate (REXC) in Turkey. I use quarterly data for Turkey over the period 1990:1 to 2008:2. The variables and the period of analysis were selected based on the availability of data and all these data was derived from Federal Reserve Bank of St Louis internet website and Central Bank of Turkey.

Hamilton defined the net oil price increase (NOPI) to be the larger of zero, and the difference between the current price of oil and its highest price in the previous four quarters.In this study, I make use of both linear and nonlinear specifications of oil shocks to empirically investigate the impact of oil price shocks on the Turkey economy.

$$NOPI_t = \max[0, (\ln(oil_t) - \ln(\max(oil_{t-1,\ldots\ldots,oil_{t-4}})))] \tag{1}$$

Mork (1989) allowed for asymmetries in the price of oil and derived positive and negative oil price shocks. Oil price change is defined as follows:

$$\begin{aligned} ROILP_t^{+} &= \max[0, (roilp_t - roilp_{t-1})] \\ ROILP_t^{-} &= \min[0, (roilp_t - roilp_{t-1})] \end{aligned} \tag{2}$$

where $roilp_t$ is the real price of oil at time *t*, $ROILP_t^+$ the real oil price increase, and $ROILP_t^-$ the real oil price decrease.

Lee *et al.* (1995) proposed a univariate regression with GARCH (p,q) error process in the quarterly rate of change in real oil price, z_t, can be represented as;

$$z_t = \alpha_0 + \sum_{i=1}^{r} \alpha_i z_{t-i} + \sum_{i=1}^{q} x_{t-i}^{'} \beta_i + \varepsilon_t, \tag{3}$$

$$\varepsilon_t I I_{t-1} \sim N(0, h_t),$$

And

$$h_t = \gamma_0 + \sum_{i=1}^{q} \gamma_i \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \gamma_{q+j} h_{t-j} \tag{4}$$

$$\text{OILVOL}=\max\left(0, \frac{\varepsilon_t}{\sqrt{h_t}}\right) \tag{5}$$

$$\text{OILVOL}=\min\left(0, \frac{\varepsilon_t}{\sqrt{h_t}}\right) \tag{6}$$

To model the asymmetric effects of oil shocks, I follow Lee et al. (1995) and Iwayemi and Fowowe (2011) in defining the oil volatility measure (OILVOL) for positive (OILVOL+) and negative (OILVOL-) oilshocks, where OILVOL+ contains all positive values of OILVOL and zero replaces negative values and OILVOL- contains all negative values of OILVOL with positive values replaced by zero.

2.2. Metodology

It is aimed to investigate whether they are stationary or not by using Augmented Dickey-Fuller (ADF) test which is proposed by D. A. Dickey ve W. A. Fuller (1979) and PP test which is proposed by Phillips and Perron (1990). Following these unit root tests, I make using of an unrestricted VAR model to analyse the impact of oil price shocks on macroeconomic variables. After estimating the VAR I first make use of the Granger-causality tests to examine if oil price shocks have had a direct impact on the macroeconomy.

To account for the sensitivity of results using this approach to cointegration to the choice of lag length, Akaike's information criterion (AIC) and the schwarz information criterion (SIC) are used. Also, in order to understand the dynamics of responses, both the impulse response functions and variance decomposition are used in a vector autoregressive (VAR) framework.

3. EMPIRICAL RESULTS

3.1. Unit root test

According to the unit root test results which are given in Table, all the variables that are used in models are observed as stationary.

Table 1
Unit Root Test

Variables	*ADF*				*PP*			
	Level		*First difference*		*Level*		*First difference*	
	Constant	*Constant +Trend*	*Constant*	*Constant +Trend*	*Constant*	*Constant +Trend*	*Constant*	*Constant +Trend*
GDP	1.723145	-1.195	-10.305*	-10.526*	1.623	-1.376	-10.259*	-10.396*
INF	-2.034	-2.654	-11.955*	-11.985*	-6.177*	-6.545*	-26.759*	-27.011*
EXPORT	-13.132*	-13.848*	-9.67*	-9.641*	-13.133*	-13.796*	-83.804*	-88.868*
REXC	-2.476	-2.516	-11.686*	-11.646*	-2.566	-2.608	-11.69*	-11.65*
OIL	0.314	-1.315	-8.315*	-8.466*	-0.177	-1.425	-9.91*	-10.903*
NOPI	-0.886	-1.671	-9.981*	-9.979*	-1.126	-1.942	-9.419*	-9.399*
ROILP+	-8.464*	-8.874*	-9.665*	-9.642*	-8.628*	-8.861*	-40.434*	-39.971*
ROILP-	-10.112*	-10.137*	-11.374*	-11.336*	-9.973*	-9.988*	-59.567*	-59.13*
OILVOL	-3.56*	-3.532*	-12.814*	-12.789*	-5.22*	-5.235*	-24.94*	-25.157*
OILVOL+	-3.221*	-2.501	-13.292*	-13.277*	-5.546*	-5.545*	-34.559*	-36.425*
OILVOL-	-4.934*	-4.954*	-15.146*	-15.098*	-4.775*	-4.801*	-19.12*	-19.091*

The values are chi-square (Wald) statistics and values in [ ] are p-values.
* Significance at 1% level.

3.2. Granger –causality Test

The relationship between oil prices and the other variables of the model, focusing on the significance of the impact of oil prices on macroeconomic variables. We carry out different tests for both linear and non-linear specifications for Turkey. Granger causality-type analysis shows us to conclude that the interaction between linear oil prices and output, inflation, and the real export is found to be significant while the interaction between net oil prices and output and inflation is found to be significant. Results of the Granger-causality tests are showed in Table 2.

Table 2 displays the p-values of the Wald test statistic, indicating that I accept the hypothesis that the different oil prices variables (in either linear or non-linear models) are statistically significant at a 5% critical level in Turkey considered. This means that oil prices appear to have a significant direct impact on real activity. Thus, the results confirm the findings of other studies, which found that oil price shocks did not have a significant effect on macroeconomic variables for years

(Burbidge and Harrison (1984; Hamilton, 1996; Lardic and Mignon, 2008). Furthermore, The finding that linear and nopi Granger-cause GDP, inflation and net exports in Turkey. I find evidence of the asymmetric effects of oil shocks on GDP.

Table 2
Granger-causality Test

Null hypothesis:oil price shocks do not Granger-cause: oil price shock measure

Variable	*OIL*	*NOPI*	*ROIL+*	*ROIL-*	*OILVOL*	*OILVOL+*	*OILVOL-*
GDP	43.685	17.87	20.0363	33.7054	0.28843	0.40223	0.12989
	[0.000]*	[0.0013]*	[0.0012]*	[0.0000]*	[0.8657]	[0.8178]	[0.9371]
ENF	8.906	10.457	5.58834	1.51529	1.47376	2.40215	1.722874
	[0.0306]*	[0.0334]*	[0.2321]	[0.4688]	[0.4786]	[0.3009]	[0.7866]
EXPORT	8.153	6.83	4.92490	0.61905	1.08249	1.324234	0.61905
	[0.0429]*	[0.0775]	[0.2951]	[0.4314]	[0.582]	[0.5158]	[0.4314]
REXC	1.0755	1.79384	0.11479	0.46985	2.25034	1.89272	0.36632
	[0.783]	[0.6163]	[0.7347]	[0.4931]	[0.3246]	[0.3882]	[0.545]

The values are chi-square (Wald) statistics and value sin[ ] are p-values.
* Significance at 1% level. ** Significance at 5% level. *** Significance at 10% level.

Figs. 1–7 in the appendix A show the impulse response functions for the responses of the macroeconomic variables to different oil price shocks. Each figure traces the effect of a one-time shock to the measures of oil shocks on the current and future values of each of the macroeconomic variables.

3.3. Variance Decomposition Analysis

Variance decomposition can indicate which variables have short-term and long-term impacts on another variable of interest. In this study, Variance decomposition analysis shows that oil price shocks are a considerable source of volatility for many of the variables in the model Table 3. presents the results of the forecast error variance decomposition.

Variance decomposition results support the findings from the Granger-causality tests. The linear benchmark of oil price (OIL) and nonlinear benchmark of oil price NOPI explain a significant proportion of variation in output, inflation and net exports. Positive oil shocks (ROILP+, OILVOL+) have a more pronounced effect than negative oil shocks on macro economic variables (ROILP-, OILVOL-) Positive real oil price increase explain 2.2–3.84% of the variation in output between the 5th and 10th periods. it seems that the negative oil shocks have a larger impact on GDP, inflation and net exports. Oil price shocks become stronger in the long-run than in the short run.

Table 3
Variance Decomposition Analysis

Dependent variable	*period*	*Oil*	*NOPI*	*ROILP+*	*ROILP-*	*OILVOL*	*OILVOL+*	*OILVOL-*
GDP	1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	5	3.046262	1.596667	2.22585	1.869771	0.211066	0.268757	0.083865
	10	3.33271	1.535139	3.843003	1.918638	0.54823	0.821562	0.137242
Inflation	1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	5	1.891754	2.332313	2.252337	1.383203	0.959897	2.012124	0.624482
	10	9.038641	11.25078	4.853784	1.543352	2.178975	4.234477	1.701753
Net exports	1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	5	0.884733	0.684208	2.809459	0.605318	0.627211	0.647692	0.351344
	10	2.285261	1.887164	3.269076	0.605319	0.763376	0.897224	0.37547
Real exchange	1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	5	0.499767	0.481901	0.10373	0.353527	0.227293	0.236165	0.407395
	10	0.389963	0.43027	0.134264	0.417821	0.746782	0.20474	0.839404

APPENDIX A

Figure 1: Impulse Response Functions of Shocks to OIL

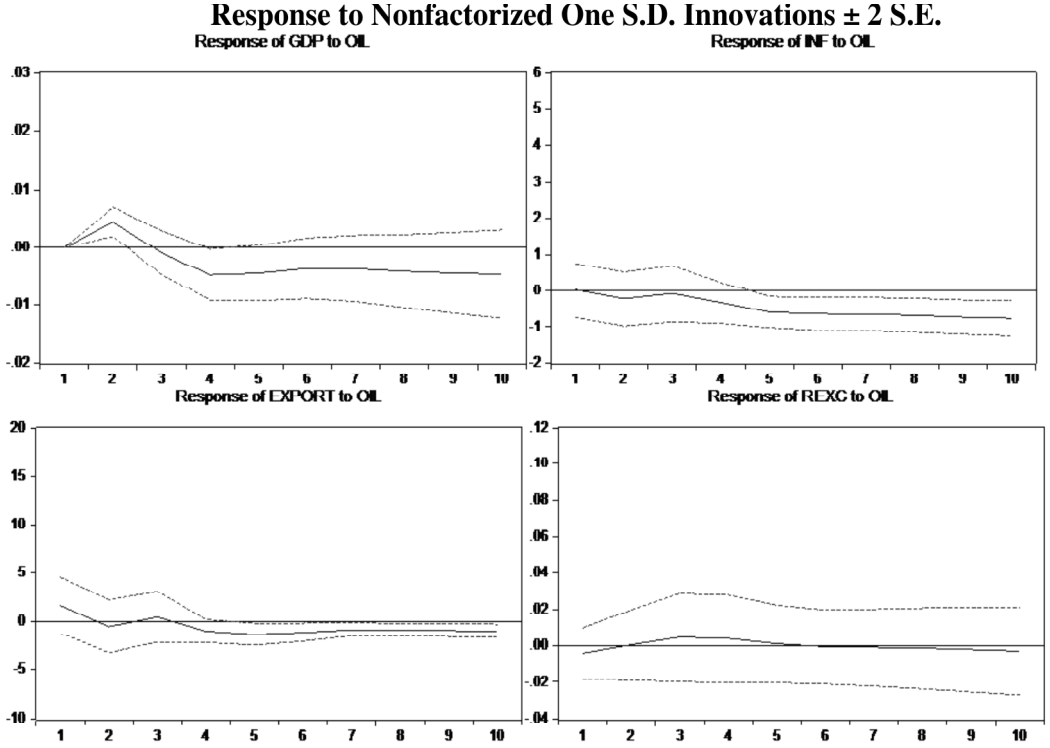


Figure 2: Impulse Response Functions of Shocks to NOPI.
Response to Nonfactorized One S.D. Innovations ± 2 S.E.

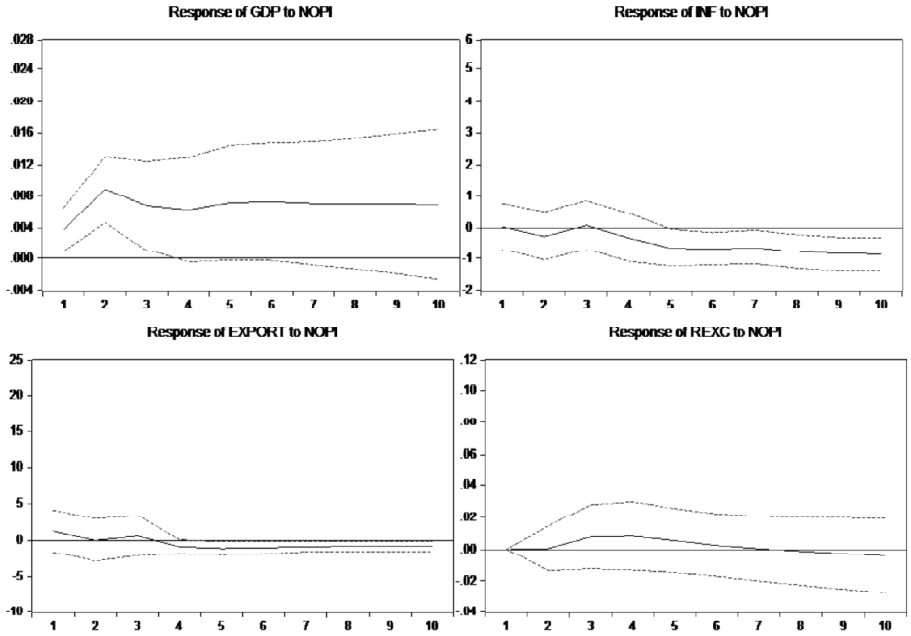


Figure 3: Impulse Response Functions of Shocks to ROILP+.
Response to Nonfactorized One S.D. Innovations ± 2 S.E.

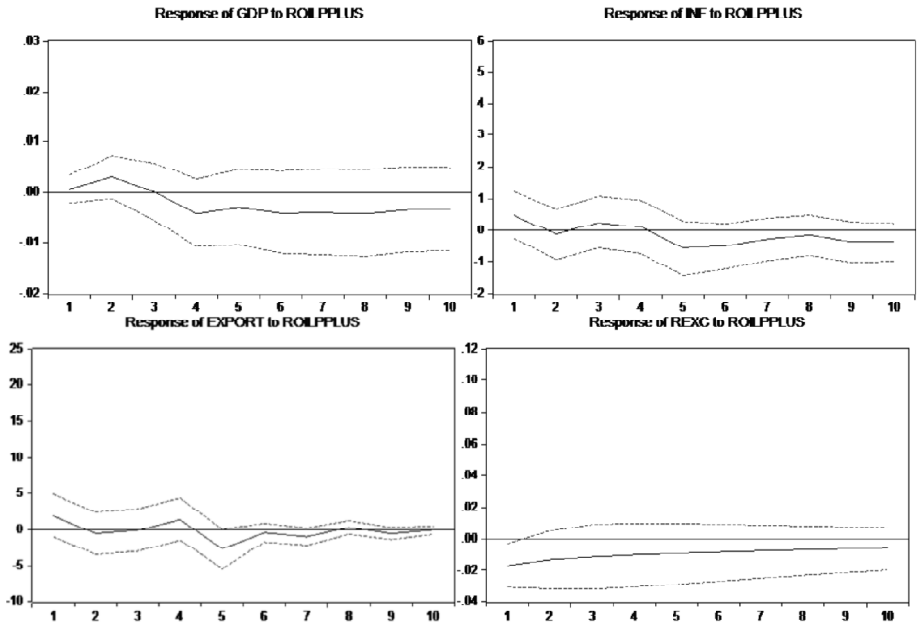


Figure 4: Impulse Response Functions of Shocks to ROILP-.
Response to Nonfactorized One S.D. Innovations ± 2 S.E.

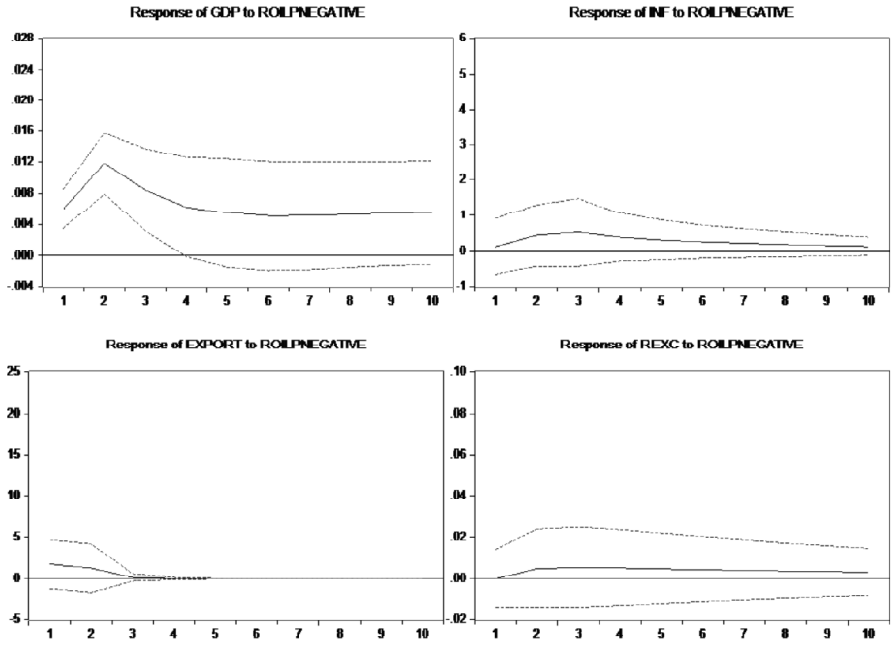


Figure 5: Impulse Response Functions of Shocks to OILVOL.
Response to Nonfactorized One S.D. Innovations ± 2 S.E.

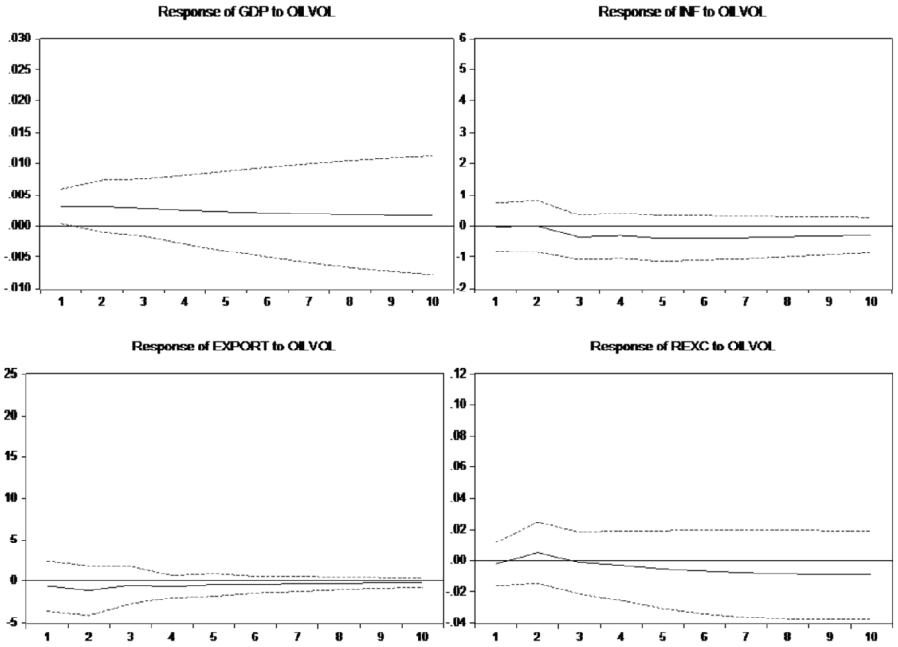


Figure 6: Impulse Response Functions of Shocks to OILVOL+.
Response to Nonfactorized One S.D. Innovations ± 2 S.E.

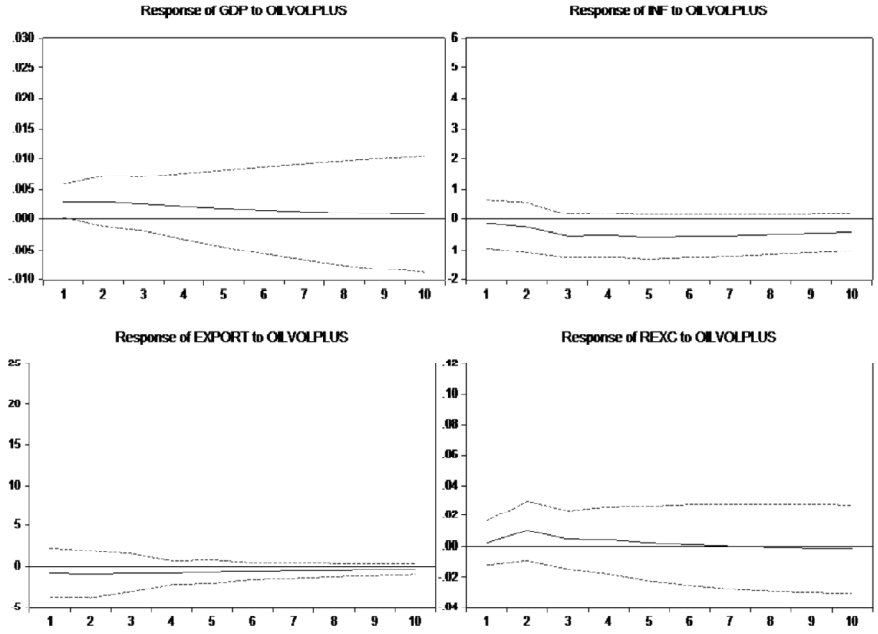
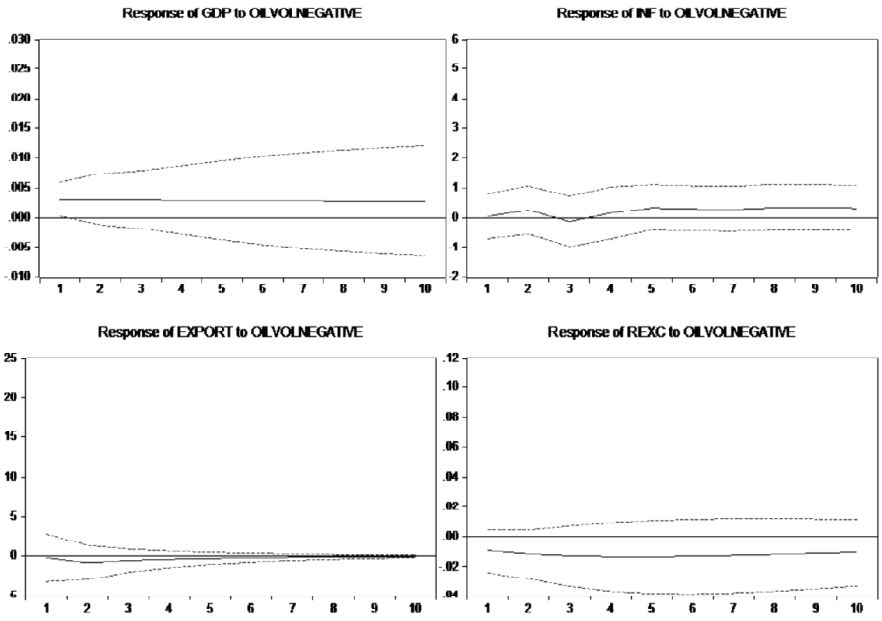


Figure 7: Impulse Response Functions of Shocks to OILVOL-.
Response to Nonfactorized One S.D. Innovations ± 2 S.E.



4. CONCLUSIONS

The study investigates impact of linear and various non-linear specifications of oil price shocks on chosen macroeconomic variables (GDP, inflation, net exports and real exchange rate) for Turkey. I find that oil price shocks have a major impact on most macroeconomic variables in Turkey. The results of the Granger- causality tests, variance decomposition and impulse and response functions analysis all showed that different measures of linear and positive oil shocks have not caused the real exchange rate. Positive oil shocks have a more pronounced effect on macroeconomic variables than negative shocks. The tests support the existence of asymmetric effects of oil price shocks because this paper finds that negative oil shocks significantly cause GDP.

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