Journal of Applied Finance & Banking, vol. 5, no. 4, 2015, 61-72
ISSN: 1792-6580 (print version), 1792-6599 (online)
Scienpress Ltd, 2015

Do Crude Petroleum Imports Affect GDP of Turkey?

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Abstract

This study examines the dynamic linkages between crude petroleum imports and GDP of Turkey. The vector autoregression analysis is carried on quarterly data for the period 1998Q1 to 2013Q2. This study utilized the generalized approach to forecast error variance decomposition and impulse response analysis which have many advantages against the traditional orthogonalized approach. The empirical results suggest that petroleum imports have positive impact on GDP until the second quarter. But, after the second quarter crude petroleum imports have negative impact on GDP. The results of the Granger causality test showed that crude petroleum imports granger caused GDP at 5% significance level, but not vice versa. Moreover, the generalized variance decomposition analysis exerted that the imports of crude petroleum shocks have only a small effect on GDP initially. However, after eighth quarters, the imports of crude petroleum shocks explain 31.7 pct. of the GDP, whereas 26.46 pct. of the variation in imports of crude petroleum shocks is explained by GDP shocks.

JEL classification numbers: O49, 053, Q41
Keywords: Vector autoregression, Generalized impulse responses, GDP, Crude petroleum imports, Turkey

1 Introduction

Petrol has been one of the mostly used and therefore consumed sources among other energy sources. Petrol consumption trends have been on the rise in recent years due to the factors such as progress in technology by the help of globalization, industrialization, increasing numbers of world population, urbanization, transportation and logistics services. Compared to the increase in demand for petrol; capacity increases in petrol supply cannot be achieved since it is not a renewable energy source leading to the result of increased petrol prices.

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Article Info: *Received :* February 15, 2015. *Revised :* March 9, 2015.
Published online : July 1, 2015

Parallel to the increase in petrol consumption, the increase in petrol prices initially raises the production costs of nations and causes cost inflation. The increase in production cost decreases the production volume, resulting in the reduction of total demand.
This study aims to analyze the dynamic relationship between the imports of crude petroleum and GDP for Turkey. For this purpose, empirical literature on the relationship between the two variables will be discussed, then the data set and the methodology that will be used in the application part of the study will be explained and finally empirical results will be evaluated.

2 Literature Review

The literature focused on the relationship between energy consumption and income dates back to the late 1970s. Kraft and Kraft (1978), in their pioneering work, concluded that GDP leads energy consumption in U.S. for the period from 1947 to 1974.
Ebohon (1996) analyzed the causal relationship between energy consumption and economic growth in Nigeria and Tanzania. The empirical results indicate that there is a simultaneous causal relationship between energy consumption and economic growth for both countries.
Masih and Masih (1996) investigated whether there is a long-run relationship between energy consumption and real income for India, Pakistan, Malaysia, Singapore, Indonesia, and Philippines. The empirical results show that temporal causality results imply at least one-way Granger causality, either unidirectional or bi-directional for India, Pakistan, and Indonesia while the simple bivariate vector autoregressive models didn't show any causality relationship for the non-integrated systems in Malaysia, Singapore, and Philippines (Chima, 2005).
Soyas and Sari (2003) tested whether there exists the causal relationship between GDP and energy consumption for the period 1950-1992 in the top 10 emerging countries and the G-7 countries using cointegration and vector error-correction techniques,. They found bi-directional causality in Argentina, uni-directional causality with energy consumption leading GDP in Turkey, France, West Germany and Japan, and the causality with GDP leading energy consumption in Italy and Korea.
Chima (2005) employed a macroeconomic model based on Multiple Model estimation in order to determine the relationship between energy consumption and GDP in the United States for the period of 1949-2003. Results based on the tools of methodology used in the study indicate that causality was bi-directional, running from energy to the components of GDP and from GDP to energy consumption.
Webb (2006) applied dynamic panel data techniques to panel of 73 countries for which oil is not a significant export in order to find price and income elasticities of oil consumption in transportation, the industrial sector and other sectors including commercial and residential. According to Webb (2006)'s the results of empirical research, the transportation sector is the only sector where an increase in the price of crude oil has a statistically and economically important effect.
Korap (2007) examined the long and short-run causal links between the changes in energy consumption, real income growth and domestic inflation in the Turkish economy for the period of 1968-2005. The authors considered the energy consumption with three different models, comprising of total energy consumption, residential and commercial energy consumption, and industrial energy consumption. As a result of their study, energy policies

designed in the framework of the expectations have the power of affecting domestic inflation significantly. In addition, they find that energy conservation policies may cause to various detrimental results for the economic growth process in the case of the use of industrial energy consumption data.

Lescaroux and Mignon (2008) investigated the short-run and long-run links between oil prices and various variables representative of economic activity: gross domestic product, consumer price index, household consumption, unemployment rate, and share prices over the period of 1960-2005. The authors find the direction of causality generally from oil prices to the other variables. According to Lescaroux and Mignon (2008)'s short-run empirical results can be summarized as: i) the impact of oil prices on consumption is generally weak. ii) Oil prices have a large effect on consumer price index for United Arab Emirates, UK, Mexico and Libya. iii) Oil prices have a large influence on the unemployment rate in the US, Luxembourg, France, Canada and Venezuela. iv) There is no causality running from oil prices to GDP for the group of oil-exporting countries. Finally, oil price movements have strongly negative influence on share prices on the short run. According to their long-run empirical results, the majority of long-run relation concerns GDP, unemployment rate and share prices.

Lee and Chang (2008) investigated the causal relationship between energy consumption and GDP over the period 1971-2002 for 16 Asian countries. According to their study, there exists a unidirectional long-run relationship running from energy consumption to economic growth, while there doesn't exist a short-run relationship between economic growth and energy consumption. Similarly, Huang et al. (2008) also investigated that the causal relationship between energy consumption and economic growth for 82 countries from 1972 to 2002. Using panel VAR approach, Huang et al. (2008) found that there exists no causal relationship between energy consumption and GDP in the low income countries, economic growth affects energy consumption positively in the middle income countries and in the high income countries economic growth affects energy consumption negatively.

Uğurlu and Ünsal (2009) used VAR models with annual data from 1971 to 2007, to analyze the short-run relationship between crude petroleum imports and economic growth in Turkey. In their analysis, Uğurlu and Ünsal (2009) found that the effect of shock in any of these two variables on the other variable is generally negative, but after three years, the effect has died out.

Leesombatpiboon (2009) measured the elasticity of economic growth with respect to oil consumption and oil prices for the Thai economy. Empirical results show that a sharp 10 percent decrease in oil prices would cause economic growth to shrink by 2 percent while a sharp 10 percent increase in oil prices would lead output growth to a fall by about 0.5 percent within the same year. This finding is interpreted as that an oil supply disruption is usually associated with a rapid rather than gradual increase in oil prices and an economy cannot adjust immediately to that shock.

Aktas et al. (2010) examined the dynamic linkages between oil prices and macro-economic variables as GNP, inflation, unemployment and ratio of exports to imports in Turkey over the period of 1991-2008. Using VAR model in order to exert these linkages, Aktas et al. (2010) concluded that a rise in oil prices do not have any substantial impact on macro-economic variables. They also found that the responses of macro-economic variables to oil price shocks become stable aftermath of one year.

3 Data and Methodology

3.1 Data

In the analysis of Turkey, we used quarterly, seasonally-adjusted data from 1998Q1 to 2013Q2. The dataset included the following variables:
gdp_sa: Real gross domestic product at constant prices (thousand TL)
imp_pet: Imports of crude petroleum (metric tons)
The variable of gdp_sa is obtained from Central Bank of the Republic of Turkey, and the variable of imp_pet is taken from Turkish Statistical Institute. In order to carry out the paper, E views 7.0 is used.

3.2 Methodology

The empirical methodology adopted in this study involves the estimation of unrestricted vector autoregressive (VAR) model. This model is used to generate impulse response functions to determine the responsiveness of the imports of crude petroleum to shocks to real GDP in the short-run. Moreover, Granger causality test and variance decomposition analysis are used to analyze the effect of crude petroleum imports on GDP.

3.2.1 Unit root characteristics

Test for stationary condition for time series is becoming vital. It is generally observed that regression estimates generated through standard estimation for non-stationary time series are misleading (Akram, 2011). The stationarity or non-stationarity of a series can strongly influence its behavior and properties. If the variables in the regression model are not stationary, then it can be proved that the standard assumptions for asymptotic analysis will not be valid (Vosvrda, 2013). According to Yule (1926), who introduced spurious regression problem and further analyzed by Granger and Newbold (1974) using non-stationary time series steadily diverging from long-run mean will produce biased standard errors, which causes to unreliable correlations and unbiased estimations within the regression analysis leading to unbounded variance process. Several different time series unit root tests are available. But the two popular unit root tests widely have been used in the applied econometric literature. These are Dickey-Fuller (DF) test proposed by Dickey and Fuller (1979) and the Phillips-Perron (PP) test proposed by Phillips and Perron (1988). The null hypothesis of both PP and DF test is that the variable contains a unit root, and alternative is that the variable was generated by a stationary process. The DF and PP tests differ mainly in how they treat serial correlation in the test regressions. DF tests use a parametric autoregressive structure to capture serial correlation, while PP tests use non-parametric corrections. We used ADF and PP tests to examine the stationarity of the time series in this study.

3.2.2 Basic VAR Model

Following seminal work by Sims (1980), the vector autoregression (VAR) approach has become increasingly popular in analysis of dynamic economic systems and has been developed as a powerful modeling technique. As VAR models generally are based on the statistical representation of the dynamic behavior of time series data with minimal restriction on the underlying economic structure and can be easily estimated, they have

become increasingly popular in both economics and finance (Wu and Zhou, 2010).
A basic p-lag VAR model can be written the following form:

$$y_t = A_0 + \phi_1 y_{t-1} + \phi_2 y_{t-2} + ... + \phi_p y_{t-p} + \varepsilon_t \qquad t=1,2,\ldots,T$$

where $y_t = (y_{1t}, y_{2t,}, ..., y_{nt})'$ and y_t is a (nx1) vector of economic time series, ϕ's are (nxn) coefficient matrices, and ε_t is a (nx1) vector of residuals. The residual vector is assumed to have zero mean, zero autocorrelation and time invariant covariance matrix Ω (Wu and Zhou, 2010). A critical component in the specification of VAR models, which are widely used in analysis of the effects of structural shocks, is the determination of the lag length of the VAR. Braun and Mittnik (1993) show that estimates of a VAR whose lag length differs from the true lag length are inconsistent as are the impulse response functions and variance decompositions derived from the estimated VAR. Similarly, Lütkepohl (1993) indicates that selecting a higher order lag length than the true lag length causes an increase in the mean-square-errors of the VAR and contrarily, selecting a lower order lag length causes autocorrelated errors (Ozcicek and Mcmillin, 1999). The number of lags is usually determined explicitly using model selection criteria. The general approach is to fit VAR(p) models with orders $p=0,\ldots,p_{max}$ and choose the value of p which minimizes some model selection criteria as the Akaike Information Criteria (AIC), the Schwarz-Bayesian Information Criteria (BIC), and the Hannan-Quinn (HQ). Once the lag length is determined, the VAR is re-estimated using the appropriate sample (Zivot and Wang, 2003).
Three important functions of VARs are their use for testing granger causality, impulse response and variance decomposition analysis. An important implication of VAR is their use for causality analysis. To test for the causal relationship between two variables researchers have used granger causality test which pointed out by Granger (1969). Granger called a variable y_{2t} causal for a variable y_{1t} if the information in past and present values of y_{2t} significantly contribute to forecast y_{1t} for some future period; otherwise it is said to fail granger-cause $y_{2t.}$ Clearly, the notion of granger causality does not imply true causality. It only implies forecasting ability (Zivot and Wang, 2003). Second implication from VAR estimation is impulse response functions (IRFs) values. These values help to estimate how a unit shock in impulse variable is responded by response variable keeping others constant. An impulse response function measures the time profile of the effect of shocks at a given point in time on the (expected) future values of variables in a dynamical system (Pesaran and Shin 1998). Other implication from VAR estimation is forecast error variance decompositions (FEVD). FEVD measure the contribution of each type of shock to the forecast error variance. Both computations are useful in assessing how shocks to economic variables reverberate through a system. Explicitly, the variance decomposition separates the variation in an endogenous variable into the component shocks to the VAR (Meniago et al. 2013).
In this paper, we use the generalized impulse response functions (GIRF) proposed by Pesaran and Shin (1998) instead of the basic IRF, since basic IRF have got several drawbacks. The results of the IRF are strongly affected by the ordering of variables. But the generalized impulse responses are invariant to the reordering of the variables in the VAR. Another drawback of the IRF is related with the omission of variables. Omitting important variables in the model may lead to major distortions in the impulse responses and structural interpretations of the results (Meniago et al. 2013; Pesaran and Shin 1998).

Briefly, the generalized approach is invariant to the ordering of the variables in the VAR and produces one unique result.

4 Empirical Results

4.1 Unit Root Tests

Many macro-economic time series contains a unit root. In such a situation, the data need to be made stationary in order to make a VAR analysis. Unit root tests are important in the investigation of the stationarity of a time series. Because, the presence of non-stationary the series makes many standard hypothesis tests invalid. Before conducting any dynamic analysis, stationarity of the two time series should be investigated using the augmented Dickey–Fuller (ADF) test and Phillips-Perron (PP) test for the null hypothesis of unit root. Two versions of these tests were considered, i.e. with a constant only and with a constant and trend.

Unit root test results are shown in Table 1. Table 1 reports the resulting values of the unit root tests for the two time series. The variable of imp_pet is stationary variable, but gdp_sa become I(0) after taking the first difference. Therefore, our VAR contains *gdp_sa* first differenced and *imp_pet* while *tg* is a trend variable which is used as an exogenous variable in the estimation VAR system.

Table 1: Unit Root Tests

	ADF		**PP**	
Variable	**Constant Trend**	**Constant**	**Constant Trend**	**Constant**
gdp_sa	-2.639	0.213	-2.571	0.559
	[0.26]	[0.97]	[0.29]	[0.98]
Δgdp_sa	-5.880*	-5.821*	-5.877*	-5.814*
	[0.00]	[0.00]	[0.00]	[0.00]
imp_pet	-4.425*	-3.600*	-4.337*	-3.600*
	[0.00]	[0.00]	[0.00]	[0.00]

* Significant at the 1% confidence level. Numbers in brackets are p-values. The max lag lengths were set to 5 and Schwarz Bayesian Criterion was used to determine the optimal lag length. Variable used in differenced form is reported with Δ as a prefix with its name.

4.2 VAR Estimation

After analyzing the data for unit root an important step for VAR analysis is to determine the lag length for the model. Different tests are being used in the literature for VAR lag order selection purposes. Popular are the final prediction error (FPE), AIC, BIC, HQ, and Likelihood Ratio (LR) test.

Table 2 reports that the appropriate number of lag length of the VAR model through the information criterions. Table 2 showed that the optimal lag length for the VAR model suggested according to LR, FPE, AIC, SC, HQ was 1 lag. Thus we used lag length 1 for our model.

Table 2: Lag Length Selection of the Model

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1655.558	NA	1.89e+23	59.26992	59.41458	59.32600
1	**-1641.614**	**25.898***	**1.32e+23***	**58.977***	**59.200***	**59.024***
2	-1639.239	4.239926	1.40e+23	58.97283	59.40683	59.14109
3	-1635.902	5.721079	1.44e+23	58.99649	59.57517	59.22084
4	-1630.764	8.441463	1.39e+23	58.95584	59.67918	59.23628
5	-1627.895	4.507193	1.45e+23	58.99626	59.86427	59.33279

Note: * Indicates lag order selected by the criterion; LR: sequential modified LR test statistic (each test at 5% level); FPE: Final Prediction Error; AIC: Akaike Information Criterion; SC: Schwarz Information Criterion; HQ: Hannan-Quinn Information Criterion.

VAR results from Turkey's time series data are given in Table 3. The results indicate that the impact of the crude petroleum imports increases (imp_pet) on GDP is both statistically significant at 10% and negative.

Table 3: Vector Autoregressive Results

	dgdp_sa	**imp_pet**
dgdp_sa(-1)	0.271975	0.011284
	(0.12535)	(0.17459)
	[2.16976]	[0.06463]
imp_pet(-1)	-0.168277	0.484446
	(0.08430)	(0.11742)
	[-1.99609]	[4.12562]
c	1117868.	3232282.
	(545471.)	(759771.)
	[2.04936]	[4.25429]
tg	-1581.407	-15102.23
	(4517.12)	(6291.76)
	[-0.35009]	[-2.40032]
R-squared	0.145138	0.468542

As we mentioned above, the interpretation of the VAR model can brought to light through the generalized variance decomposition analysis and the estimation of the generalized impulse response functions. The generalized impulse response functions are showed in Figure 1.

The impulse response functions of the model showed that a positive shock to GDP led to a positive and significant response of the imports of crude petroleum from the first quarter until the fifth quarter, but aftermath of the fifth quarter the response of the imports of crude petroleum declined gradually and become insignificant. Moreover, Figure 1 showed that a positive shock to the imports of crude petroleum led to an increase in GDP until the second quarter. Aftermath of the second quarter a positive shock to the imports of crude petroleum led to a decrease in GDP and the response of GDP to crude petroleum imports declined gradually.

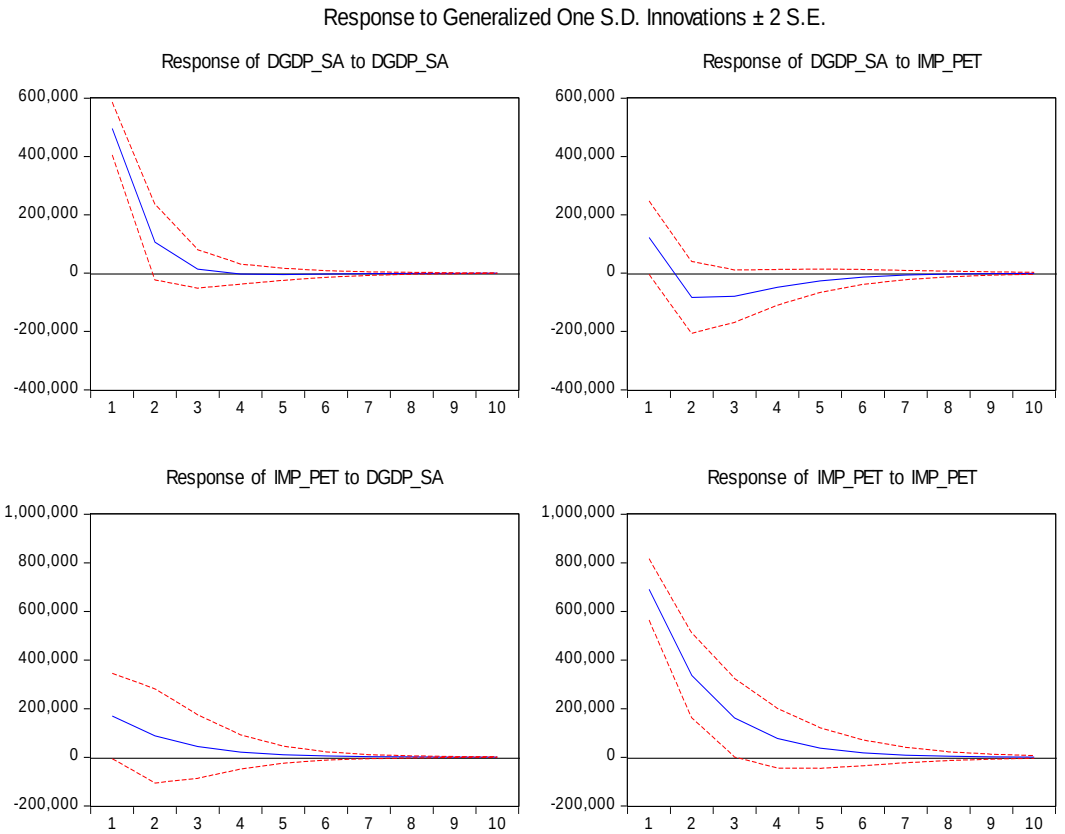

Figure 1: The Generalized Impulse Response Functions

The results of Granger causality test are presented in Table 4. The empirical findings in Table 4 showed that imp_pet Granger caused GDP at 5% significance level. However, GDP did not Granger cause imp_pet.

Table 4: Granger Causality Test

Dependent variable: dgdp_sa			
Excluded	Chi-sq	df	Prob.
imp_pet	3.984362	1	0.0459
Dependent variable: imp_pet			
Excluded	Chi-sq	df	Prob.
dgdp_sa	0.004177	1	0.9485

The results of the generalized variance decomposition analysis are illustrated in Table 5. The results of generalized variance decomposition analysis and generalized impulse response function provide the same conclusions regardless of decomposition order since their estimation is independent of the ordering.

In Table 5, the generalized variance decomposition showed that imp_pet was important source of shocks in GDP. The imports of crude petroleum shocks have only a small effect on GDP initially. However, after eighth quarters, the imports of crude petroleum shocks explain 31.7 pct. of the GDP (increasing to 50 pct. after the sixteenth quarter), whereas

26.46 pct. of the variation in imports of crude petroleum shocks is explained by GDP shocks (increasing to 33.26 pct after the sixteenth quarter).

Table 5: The Generalized Variance Decomposition of GDP and the Imports of Crude Petroleum

Variance Decomposition of dgdp_sa		
Period	**dgdp_sa**	**imp_pet**
4	99.75955	0.240448
8	68.22652	31.77348
12	67.00793	32.99207
16	51.11958	48.88042
20	49.48295	50.51705
Variance Decomposition of imp_pet		
Period	**dgdp_sa**	**imp_pet**
4	5.880849	94.11915
8	26.46227	73.53773
12	34.20461	65.79539
16	33.26158	66.73842
20	31.47503	68.52497

4.3 Model's Specification Tests

4.3.1 Stability Condition Test

Lastly model's estimates are further tested for stability through eigenvalues stability condition. If the modulus of each eigenvalue of companion matrix is strictly less than 1, then the VAR model is stable. Eigenvalues modulus for the selected country gives results that all eigenvalues are inside the unit circle. Thus our VAR model fulfills the stability condition. Eigenvalues stability test graph and table for the country obtained from E-views 7 are reported in Figure 2 and Table 6, respectively.

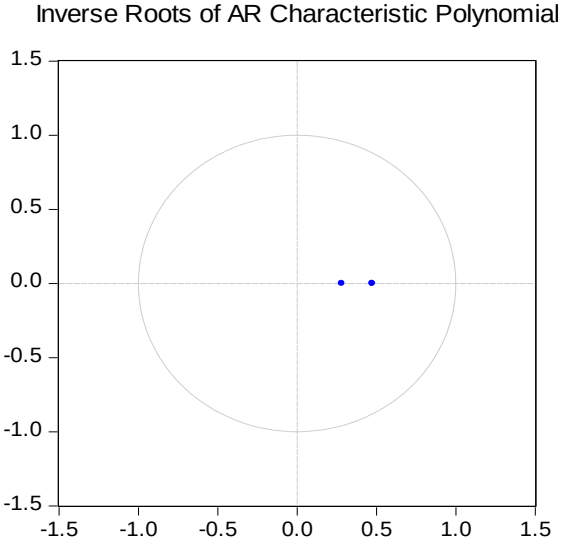

Figure 2: Roots of Companion Matrix

Table 6: Eigenvalue Stability Condition

Eigenvalue	Modulus
0.475097	0.475097
0.281323	0.281323

No root lies outside the unit circle.

VAR satisfies the stability condition.

4.3.2 Lag Order Autocorrelation Test

VAR estimates are also tested for lag order autocorrelation. Lagrange-Multiplier (LM) test for residual autocorrelation suggested by Johansen (1995) is applied. The null hypothesis of the test is no autocorrelation at lag orders. LM residual test results are presented in Table 7. According to Table 7, we can't reject the null hypothesis in the selected VAR (1) model. Therefore, our VAR model has no lag order autocorrelation.

Table 7: VAR Residual Serial Correlation LM Test

Lags	LM-Stat	Prob
1	2.125728	0.7126
2	5.451021	0.2441
3	2.875122	0.5789
4	9.639104	0.0470
5	1.892419	0.7555

5 Conclusion

The relationship between the imports of crude petroleum and GDP has a special importance in designing discretionary macroeconomic policies for stabilization purposes for developed as well as developing countries**.** Thus revealing and the magnitude the direction of this relation between the series give important signal in policy implementation process so as to assess the long-run course of the energy policies to economic agents and policy makers.
This paper examines the dynamic linkages between crude petroleum imports and GDP of Turkey. The vector autoregression analysis is carried on quarterly data for the period 1998Q1 to 2013Q2. This study utilized the generalized approach to forecast error variance decomposition and impulse response analysis which have many advantages against the traditional orthogonalized approach. According to the empirical findings, crude petroleum imports have positive impact on GDP until the second quarter. But, after the second quarter crude petroleum imports have negative impact on GDP. When analyzing the impact of GDP on crude petroleum imports, we have evidence that a positive shock to GDP led to a positive and significant response of the imports of crude petroleum from the first quarter until the fifth quarter, but aftermath of the fifth quarter the response of the imports of crude petroleum declined gradually. Moreover, the results of the Granger causality test showed that crude petroleum imports granger caused GDP at 5% significance level, but not vice versa. The generalized variance decomposition analysis exerted that the imports of crude

petroleum shocks have only a small effect on GDP initially. However, after eighth quarters, the imports of crude petroleum shocks explain 31.7 pct. of the GDP, whereas 26.46 pct. of the variation in imports of crude petroleum shocks is explained by GDP shocks. Consequently, we can say that the import of crude petroleum is important variable on the variation of GDP of Turkey.

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