IMPACT OF OIL AND NATURAL GAS PRICES ON THE TURKISH FOREIGN TRADE BALANCE: UNIT ROOT AND COINTEGRATION TESTS WITH STRUCTURAL BREAKS

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Abstract

Energy is one of the main inputs in the industrial production process. There have been remarkable increases in global production with the industrial revolution and globalization. The raising energy demand as a result of the increases in global production has been predominantly met by nonrenewable resources such as oil, natural gas and coal. Consequently we have experienced significant increases in energy prices especially as of oil shocks in 1970s. This study investigates the role of energy in the chronic foreign trade deficits of Turkey by using Hatemi-J (2008) cointegration test and Toda-Yamamoto (1995) causality test during the period 1997:01-2015:03. We found that there was long run relationship among the foreign trade deficit, oil and natural gas prices and real effective exchange rate and there was unidirectional causality from oil and natural gas prices to the foreign trade balance..

Keywords: Foreign trade balance, crude oil price, natural gas price, cointegration with structural breaks, causality test

JEL Classification: F32, F36, O16, O57, Q43

1. Introduction

Industrial production has increased continuously with the industrial revolution and globalization process. Increases in the energy prices have

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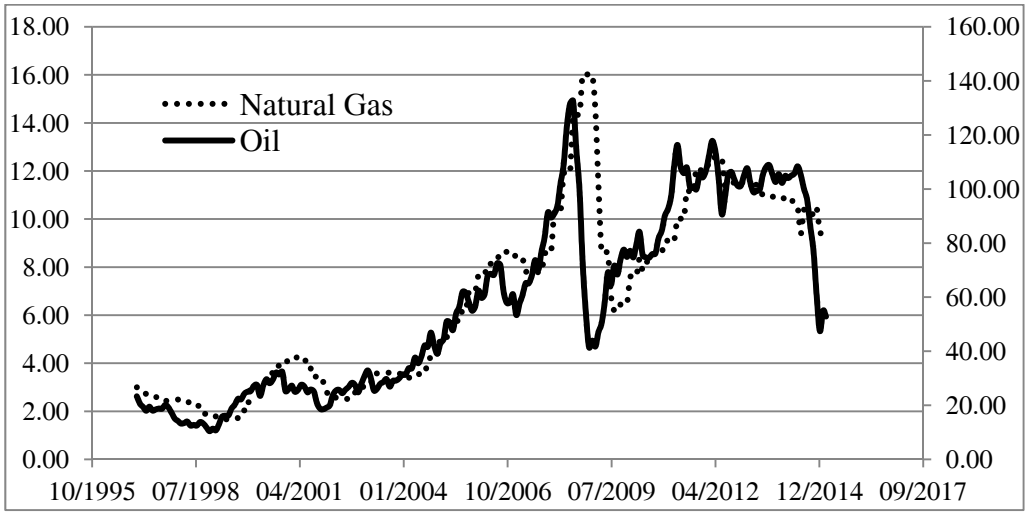
accompanied with the increases in production. The course of the crude oil and natural gas prices were presented in Chart 1. The sharp increases in energy prices has had caused disruptive effects in the economies of the countries which are net energy importers.

Chart no.1 Crude oil price* and natural gas price (1997:01-2015:03)**



Source: *IMF (2015)*, Primary Commodity Prices

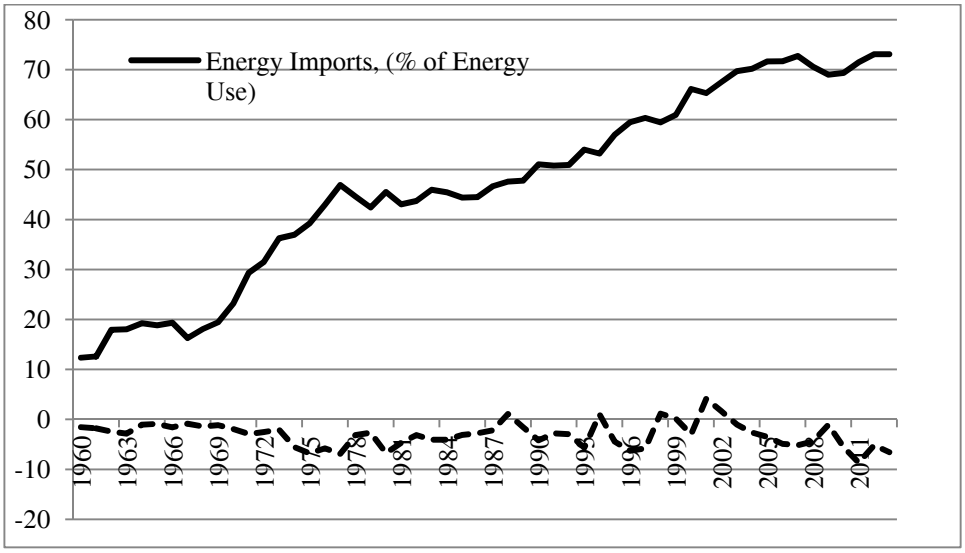
* USD per barrel (simple average of Dated Brent, West Texas Intermediate, and the Dubai Fateh spot prices)

** USD per million metric British Thermal Unit (Russian natural gas border price in Germany)

Increases in prices of oil and natural gas affects the economies through monetary, trade and financing effects (Bernanke et al. (1997)). Trade effects emerge from the changes in quantities and prices of the exported and imported goods due to increases in energy prices. On the other hand the monetary effects emerge from the deflationary pressure as a consequence of the reactions by monetary authorities. Finally financing effects emerge from the capital transfers due to increases in asset prices and profits in energy exporting countries (Bernanke et al., 1997:1415).

Current account deficit is a chronic problem of Turkish economy and foreign trade deficits have had the largest share in current account deficits. Turkey has had experienced trade deficits since 1950s. The Turkish foreign trade balance during the period 1960-2013 was presented in Chart 2. Turkish economy had trade deficits except crisis years such as 1994, 1998, 1999, 2001 and 2002 during this period. On the other hand Turkey is a net energy importer and provides most of the energy requirement by import. The energy import as a percent of energy use reached from 12.33% in 1960 to 73.10% in 2012. So Turkey becomes vulnerable to the possible increases in the energy (especially oil and natural gas) prices.

Chart no.2 Energy imports (% of energy use) in Turkey (1960-2013)



Source: *World Bank (2015a and 2015b)*

This study examines the relationship between crude oil and natural gas prices and foreign trade balance in Turkey during the period 1997:01-2015:03 by using Hatemi-J (2008) cointegration test and Toda-Yamamoto (1995) causality test. The remainder of the study is structured as follows. The next section overviews the existing literature on the relationship between energy prices and foreign trade balance. Section 3 introduces the data and the method,

Section 4 presents and discusses empirical findings of the study and Section 5 presents conclusion and policy implications.

2. Literature Review

Oil shocks in 1970s led the economist to study on the effects of changes in oil prices on macroeconomic variables such as economic growth, stock markets and current account deficits (See Hamilton (1983), Behmiri and Manso (2014), Aucott and Hall(2014), Pradhan et al.(2015)). However there have been relatively few studies on the relationship between energy prices (especially oil) and foreign trade balance in the literature. These few empirical studies generally have found that increases in oil prices had positive impact on foreign trade deficits (See Gocer(2013), Bayat et al. (2013), Atay-Polat and Sancar (2015)).

In one of these studies, Kilian (2009) investigated the impact of crude oil demand and supply shocks on external accounts including change in net foreign assets, current account, trade balance, oil trade balance, non-oil merchandise trade balance, capital gains on gross foreign assets and liabilities both in major oil exporters and importers during the period 1970–2005. They found that the net impact of oil demand and supply shocks on the balance of oil importers and exporters depends considerably on the reaction of non-oil trade balance.

In another study Allegret et al.(2014) examined the impact of oil price shocks on global imbalances in 30 oil exporters and importers during the period 1980-2011 by using global VAR approach and they found that oil shocks led increases in current account deficits in oil importer. On the other hand Schubert (2014) investigated the impact of an oil shock on key macroeconomic variables for a small open economy and found that an increase in oil price affects current account in the first stage, but later the trade balance improves sufficiently in order to cause the current account to give a surplus.

The empirical studies generally have focused on the relationship between oil prices and current account deficits in Turkey. In one of these studies Demirci and Er (2007) examined the impact of crude oil price on the current account deficits in Turkey during the period 1991-2006 by using ARMAX, VAR and cointegration analysis and found that there was long run relationship between crude oil price and current account deficit.

In another study Demirbas et al. (2009) examined the impact of oil prices on the current account deficits in Turkey during the period 1984-2008 by using Engle-Granger cointegration and vectore error correction model and found that oil prices had positive impact on the current account deficits. In another study Erdoğan and Bozkurt (2009) examined the major determinants of current account deficits in Turkey during the period 1990-2008 by using MGARCH models and found that oil prices had positive impact on current account deficits.

Irhan et al. (2011) examined the determinants of Turkish trade balance during the period 1990-2007 by using ARDL bound test and found that crude oil prices had no significant impact on trade balance. On the other hand Bayat et al. (2013) investigated the relationship between foreign trade deficit and real oil price in Turkey during the period January 1992-April 2012 by using nonlinear cointegration and causality. They found there was a uni-directional causality from real oil price to foreign trade balance in the mid run, the effect of oil price volatility on foreign trade balance disappeared in the long run. In another study Bayar et al. (2014) examined the determinants of current account deficits in Turkey during the period 2000:Q4–2013:Q3 by using impulse-response analysis, variance decomposition analysis and Granger causality test and found that crude oil price was one of the important determinants of current account deficits in Turkey.

In another study Gocer (2013) examined the major causes of current account deficits in Turkey during the period 1996-2012 by using VAR model, Johansen and VEC methods and found that 37% of the current account deficit was arisen from energy import. On the other hand Atay-Polat and Sancar (2015) examined the relationship between foreign trade deficits and real oil prices in Turkey during the period 1984-2014 by using VAR model and Granger causality test and found that there was unidirectional causality from oil prices to foreign trade deficits.

3. Data, Method and Econometric Application

We examined the impact of energy prices including oil and natural gas on foreign trade balance of Turkey in this study. Firstly, we conducted the stationarity test of the time series with Lumsdaine-Papell (1997) unit root test. We then tested the long run relationship among the variables by Hatemi-J (2008) cointegration test. Finally the causality among the variables was tested by Toda-Yamamoto (1995) causality test.

3.1. Data

We used monthly data of foreign trade balance (TB), crude oil price as USD per barrel (OIL) and natural gas price (USD per million metric British Thermal Unit) (GAS) during the period 1997:01- 2015:03 to investigate the relationship among foreign trade balance, crude oil, natural gas, real effective exchange rate. The variables used in the econometric analysis, their symbols and sources were presented in Table 1. We used Eviews 8, Gauss 10 and WinRATS 8 software packages in the analysis of the dataset.

Table no.1 Variables used in the econometric analysis

Variables	Symbols of the variables	Data Source
Foreign trade balance	TB	Turkish Statistical Institute
Crude oil price (USD per barrel)	OIL	IMF
Natural gas price (US$ per million metric British thermal unit)	GAS	IMF

3.2. Lumsdaine and Papell (1997) Unit Root Test

The events such as financial crises, political turmoil and natural disasters may cause structural breaks in time series. Therefore it is important to use tests which consider structural breaks in analysis of time series. In this study we used Lumsdaine and Papell (1997) unit root test.

The traditional unit root tests such as Augmented Dickey–Fuller (ADF) (1981) and Phillips Perron (1988) do not consider the structural breaks in the series, while testing the stationarity of the series. But the traditional unit root tests gave wrong results in case there is structural breaks in the series. Then Zivot and Andrews (1992) and Perron (1997) developed unit root tests consider one structural break in the series. Lumsdaine-Papell (1997) extended the Zivot and Andrews (1992) unit root test and introduced a new unit root test which considers two structural breaks in the series. Lumsdaine-Papell (1997) unit root

test is the improved version of ADF which includes two endogenous structural breaks and can be expressed as follows:

$$\Delta y_t = \mu + \beta_t + \theta DU1_t + \gamma DT1_t + \omega DU2_t + \varphi DT2_t + \alpha y_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-i} + \varepsilon_t \qquad [1]$$

In [1] numbered equation the indicator dummies $DU1_t$ and $DU2_t$ represent the structural changes in the intercept at TB_1 and TB_2, while $DT1_t$ and $DT2_t$ represent the structural breaks in the trend at TB_1 and TB_2.

$DU1_t = 1\ if\ t > TB1$ and otherwise zero; $DU2_t = 1\ if\ t > TB2$ and otherwise zero and $DT2_t = t - TB2\ if\ t > TB2$ and otherwise zero.

We selected the model which enables the structural breaks in both constant and trend and applied the test. The results of the Lumsdaine-Papell (1997) unit root test were presented in Table 2. The results denoted that all the variables were not stationary in the level because the test statistics were lower than critical values. Therefore the null hypothesis (series has unit root test) was accepted.

Table no.2 Results of Lumsdaine and Papell (1997) unit root test

Variables	TB1	TB2	Test statistics	Lag length
TB	November 2003	September 2010	-4.7886	9
OIL	December 2004	June 2012	-4.1503	13
GAS	July 2004	January 2009	-5.8783	10

Note: Critical values were - 7.1900 at 1% significance level, - 6.7500 at 5% significance level and - 6.4800 at 10% significance level.

TB1 and TB2 were the first and second structural breaks respectively.

3.3. Hatemi-J (2008) Cointegration Test

Hatemi-J (2008) cointegration test is the extended version of Gregory and Hansen (1996) cointegration test which allows one structural breaks among the

series. Hatemi-J (2008) cointegration test allows two structural breaks both in constant and trend and the model is as follows:

$$y_t = \alpha_0 + \sum_{i=1}^{2} (\alpha_i D_{it} + \beta_i' D_{it} x_t) + \beta_0' x_t + u_t \qquad [2]$$

In the [2] numbered equation, α_0 is the constant term before the structural breaks, α_1 and α_2 respectively is the change in the constant term due to the first and second structural breaks. On the other hand β_0 is the trend term before the structural breaks, β_1 and β_2 respectively is the change in the trend term due to the first and second structural breaks. The dummy variables D_{1t} and D_{2t} reflects the effects of structural breaks in the model. D_{1t} is 1 if $t > n\tau_1$, otherwise zero. On the other hand D_{2t} is 1 if $t > n\tau_2$, otherwise zero. τ_1 and τ_2 represent the unknown parameters which show timing of regime change point (Yılancı and Öztürk, 2011)

The test of null hypothesis (there is no cointegration among the variables) is conducted by using ADF^*, Z_α and Z_t test statistics. ADF^* is calculated by applying ADF unit root test statistics to the residuals obtained from the [2] numbered equation. On the other hand Z_α is calculated by using $Z_\alpha = m(\hat{\rho}^* - 1)$. $\hat{\rho}^*$ is the estimator of first-order autocorrelation coefficient which its bias is adjusted. On the other hand Z_t is calculated by using $Z_t = \frac{(\hat{\rho}^* - 1)}{\left[\hat{\gamma}(0) + 2\sum_{j=1}^{B} w(j/B)\hat{\gamma}(j)\right] / \sum_1^{n-1} \hat{u}_t^2}$ (Hatemi-J, 2008).

We used Hatemi-J (2008) cointegration test considering two structural breaks to determine the long run relationship among the variables. We selected the model which allows structural breaks both in constant and trend. The results of Hatemi-J (2008) cointegration test were presented in Table 3. The results demonstrated that the series were cointegrated according to the statistics Z_t and Z_α provided by Phillips test.

Table no.3 Results of Results of Hatemi-J (2008) cointegration test

Test		TB1	TB2	t statistic	Critical values*	
					5%	10%
ADF test		November 2000	November 2007	-5.828	-6.458	-6.224
Phillips	Z_t	December 2003	October 2007	-8.140	-6.458	-6.224
	Z_α	December 2003	October 2007	-97.509	-83.644	-76.806

* Critical values were obtained from Hatemi-J (2008:501)

Note: TB1 and TB2 denote the first and second structural breaks respectively.

3.4. Toda and Yamamoto (1995) Causality Test

Toda and Yamamoto (1995) causality test is a modified version of Granger (1969) causality test and test the causality among the variables without pretesting cointegration. Firstly the optimal lag length p is determined in the VAR model, then the highest integration degree (d_{max}) among the variables is added to the p and ordinary least squares model is estimated with the variables at the level for the $p + d_{max}$ lag. At final stage the constraints are imposed on the variables respectively and the significance of these constraints are tested by using standard Wald test for p lag (Büyükakın et al., 2009).

We applied Toda-Yamamoto (1995) causality test to determine the causality among the foreign trade balance, oil price and natural gas price and the results of causality test were presented in Table 4. We checked autocorrelation and heteroscedasticity problems in this model and foun that there was no autocorrelation and heteroscedasticity problems. The findings of the causality test denoted there was unidirectional causality from both oil price and natural gas price to the foreign trade balance. On the other hand there was unidirectional causality from natural gas to oil price.

Table no.4 Results of Toda-Yamamoto (1995) causality test

Null Hypotheses	MWALD	Prob.
OIL does not Granger cause of TB	21.95446	0.0000
GAZ does not Granger cause of TB	18.22039	0.0001
TB does not Granger cause of OIL	2.309276	0.3152
GAZ does not Granger cause of OIL	6.942319	0.0311
TB does not Granger cause of GAS	2.976314	0.2258
OIL does not Granger cause of GAS	1.009860	0.6035

4. Conclusion

We examined the impact of crude oil prices and natural gas prices on these chronic deficits in Turkey which is a net oil and natural gas importer . Firstly we tested the stationarity of the variables by Lumsdaine and Papell (1997) unit root test which consider structural breaks. We found that all the variables in the study had unit roots. Then we analyzed the long run relationship among foreign trade balance, crude oil price and natural gas price with Hatemi-J (2009) cointegration test allowing two structural breaks and the results demonstrated that there was long run relationship among the variables. Finally the causality among the variables was tested with Toda and Yamamoto (1995) causality test and the findings denoted that there was unidirectional causality from crude oil price and natural gas to the foreign trade balance.

Consequently our study showed that crude oil and natural gas are the determinants of the foreign trade deficits in Turkey. Therefore energy importer countries such as Turkey should take measures in order to avoid the devastating effects of changes in both crude oil price and natural gas price in the mid and

long run maybe they should increase the share of alternative energy sources such as renewable energy, nuclear energy, windpower plants.

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