

Oil Consumption and Economic Growth in Turkey: An ARDL Bounds Test Approach in the Presence of Structural Breaks

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Abstract

The aim of this study is to investigate the relationship between oil consumption and income in Turkey, using annual data from 1961 to 2016. The stationarity properties of the series are analyzed with Lee and Strazicizh (2003), unit root test allowing for two structural breaks, along with the conventional unit root tests namely ADF, PP and KPSS. Due to conflicting findings of the unit root tests, ARDL bounds test approach to cointegration is used to capture the relationship between oil consumption and income. The findings of the ARDL bounds test indicated that oil and income are cointegrated. The causal relationship between the variables is also examined by employing Toda and Yamamoto (1995), approach to Granger non-causality. The outcomes of the Toda and Yamamoto (1995), procedure showed that the direction of the causality is running from real GDP to oil consumption, but not vice versa. Both bounds test and Toda and Yamamoto (1995), test results reveal that, energy conservation policies will not harm economic growth in Turkey.

Keywords: Oil consumption; Economic growth; Turkish economy; ARDL.



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1. Introduction

Two major oil crises stimulated by the dramatic increases in oil prices adversely affected the world economy in 1970's. Since then, the relationship between energy use and economic growth has been a central issue for researchers. As uncovering the relationship between energy use and economic growth may have important policy implications regarding a country's energy policy, many studies have been devoted to shed more light on the energy use-income relationship. To this extend, four main types of hypotheses which reflects the possible relationships between energy use and economic growth are tested. Growth hypothesis suggests a unidirectional relationship running from energy use to economic growth, while conservation hypothesis also proposes a unidirectional relationship but this time running from economic growth to energy use. According to the feedback hypothesis both energy use and economic growth affects each other, implying that there exists bi-directional relationship between the variables. Finally, neutrality hypothesis claims that economic growth does not lead to any significant changes in energy use and vice versa.

Turkey is an "energy corridor" between the energy exporter countries of the Middle East and the energy importer countries of Europe due to its geographical location. As Turkey is a fast industrializing country, economic activities in Turkey depends heavily on energy inputs. Thus, any surges in energy consumption may lead to fluctuations in economic activity. Furthermore, changes in economic growth rates may also cause changes in Turkey's energy necessity. Therefore, uncovering the existence and the direction of the relationship between energy use and economic growth for Turkey may bring important policy implications.

Since, oil has the highest share in Turkey's energy use and Turkey is also heavily dependent on imports to meet its oil demand, oil consumption is used as a proxy for energy use in this study. This paper aims to address the question whether there exists a relationship between oil use and economic growth in Turkey for the period 1960-2016. To uncover the oil use-economic growth relationship for Turkey, Auto Regressive Distributed Lag (ARDL) modeling approach to co-integration developed by Pesaran and Pesaran (1997), and Toda and Yamamoto (1995), causality test are employed.

The main contribution of this paper to the existing literature is taking into account the effects of structural breaks and using the structural break dates as explanatory variables in the estimated ARDL models by using the most recent data for the case of Turkey.

The paper proceeds as follows. A brief review of the existing literature is presented in section 2. In section 3, the description of the data and methodology are introduced. In section 3 the empirical results obtained from the model(s) are reported. Finally, by discussing the outcomes, policy suggestions regarding Turkey's energy policy are presented in section 5.

2. Literature Review

In their pioneering work (Kraft and Kraft, 1978) find unidirectional causality running from GNP to energy use in the US for the period 1947-1974. However, Akarca and Long (1980), and Yu and Hwang (1984), suggest that energy use and GNP to be neutral for the US, when the period covered is changed. Moreover, Yu and Choi (1985), provide support for neutrality hypothesis not only for the US but also for the UK and Poland. On the other hand, Yu and Choi (1985), find unidirectional causality running from energy use to income for Philippines, and income to energy use for South Korea.

Following these seminal works, many researchers have investigated the energy use-income relationship for different countries, over different periods and by employing different techniques. However, the results are still contradictory. Some researchers report unidirectional causality running from income to energy use, such as, Abosedra and Baghestani (1989), for the US, Masih and Masih (1996), for Indonesia, Soyatas and Sari (2003), for Italy and Korea, Lee (2006), for France, Italy and Japan, Zamani (2007), for Iran, Ghosh (2009), for India, Yazdan and Hossein (2012), for Iran, Alam and Paramati (2015), for 18 developing countries, Saboori *et al.* (2017), for South Korea.

On the other hand, some researchers find reverse unidirectional causality, running from energy to income, such as; Masih and Masih (1996), for India, Stern (2000), for the US, Soyatas and Sari (2003), for France, Japan and West Germany, Oh and Lee (2004), for Korea, Lee (2005), for 18 developing countries, Soyatas and Sari (2006), for France and the US, and Yuan *et al.* (2007), for China, Saboori *et al.* (2017), for China and Japan.

Bidirectional relationship also found in some studies, such as; Erol and Yu (1987), for Japan, Masih and Masih (1996), for Pakistan, (Glasure and Lee, 1997) for South Korea and Singapore, and Masih and Masih (1997), for Korea and Taiwan, Hondroyiannis *et al.* (2002), for Greece, Ghali and El-Sakka (2004), for Canada, Soyatas and Sari (2006), for Canada, Italy, Japan and UK, Yuan *et al.* (2008), for China, Bhusal (2010), for Nepal, Al-Mulali (2011), for MENA countries, Behmiri and Manso (2013), for Sub-Saharan Africa, Park and Yoo (2014), for Malaysia, Wang *et al.* (2016), for China and Pinzón (2018), for Ecuador.

Despite the fact that most of the empirical studies found evidence in favor of the relationship between income and energy use, some researchers provide evidence of energy use and income to be neutral, such as, Cheng (1995), for the US, Masih and Masih (1996), for Malaysia, Singapore and the Philippines Cheng and Lai (1997), for Taiwan, Glasure (2002), for Korea, Soyatas and Sari (2003), for the US, the UK, Canada, Indonesia and Poland and Lee (2006), for the UK, Germany and Sweden.

The controversy about the existence and the direction of the relationship between energy use also holds for the studies concerning Turkey. Soyatas *et al.* (2001), Soyatas and Sari (2003), Altinay and Karagol (2005), Mucuk and Uysal (2009), Karagöl *et al.* (2011), Ceylan and Başer (2014), and Keskin (2017), provide support for unidirectional causality running from energy to income, while the findings of Lise and Van Montfort (2007), Ozata (2010), Gokmenoglu and Taspinar (2016), and Aydin (2018), show unidirectional causality running from economic growth to energy consumption. The validity of the feedback hypothesis is confirmed by the findings of Aktas and Yilmaz (2008), Saatci and Dumrul (2012), and Ozturk and Acaravci (2013). In contrast to these findings, Altinay and Karagol (2004), Soyatas and Sari (2009), Ozturk and Acaravci (2010), and Ucak and Usupbeyli (2015), suggest that energy use and income to be neutral for the case of Turkey.

3. Data, Model and Methodology

3.1. Data

Annual data for Turkey over the period 1960–2016 is used to investigate the dynamic relations between oil consumption and income. Real GDP and total primary energy supply (TPES) from oil were used as proxies for income and oil consumption, respectively. Real GDP is measured in US dollars (base year=2010) and oil use measured in thousand tonnes of oil equivalent (toe). The data for the Real GDP was obtained from World Development Indicators database of the World Bank and oil information is taken from the World Energy Statistics and Balances of the International Energy Agency which is available at the OECD database.

3.2. Model

In order to test whether there exists a relationship between oil consumption and income the following models are used.

$$o_t = f(y_t) \quad (1)$$

$$y_t = f(o_t) \quad (2)$$

where t denotes time, o refers to oil consumption and y represents income.

The models represented with Equation 1 and Equation 2 are transformed into the following log-log models in order to capture the long run elasticities of the variables.

$$lo_t = \alpha_0 + \alpha_1 ly_t + \epsilon_{1t} \quad (3)$$

$$ly_t = \beta_0 + \beta_1 lo_t + \epsilon_{2t} \quad (4)$$

where t refers to time, o_t is the log of oil consumption, ly_t is the log of income, α_j 's and β_j 's are OLS estimators and ϵ_{jt} 's are the white noise terms.

4. Methodology

The dynamic relations between oil consumption and income are investigated by using linear time series techniques. One of the most important problems while working with the time series data is the possibility of spurious regression. In order to overcome the spurious regression problem, the stationarity properties of the series in question are analyzed by using the conventional stationarity tests, which do not take into account the structural breaks, namely Augmented Dickey Fuller (ADF), Phillips-Perron (PP) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS). Moreover, recently developed Lee and Strazicizh (2003), (LS) unit root test which allows for two structural breaks is also employed in this study.

VAR models and residual or maximum likelihood based cointegration tests like Engel and Granger (1988), Johansen (1988), Johansen and Juselius (1990), and Gregory and Hansen (1996a), Gregory and Hansen (1996b), are widely used methods by the researchers to capture the inter-relations between the variables in question. Since these methods deal only with the variables integrated of the same order, using these methods may cause biased results when the series have different stationarity properties. In such cases, ARDL bounds test approach to cointegration, which is a relatively recent technique developed by Pesaran and Pesaran (1997), Pesaran and Smith (1998), Pesaran and Shin (1999), Pesaran *et al.* (2001), and Pesaran and Pesaran (2010), is one of the best suitable methods.

As shown by Pesaran *et al.* (2001), the first advantage of the ARDL procedure is that, it can be used whether the series are I (0) or I (1) or mutually cointegrated. Second, it also allows for estimating both short-run and long run properties of the series simultaneously. Third, as emphasized by Narayan (2005), the estimated coefficients are consistent and unbiased even in small sample sizes. Since all variables are assumed to be endogenous; as argued by Laurenceson and Chai (2003), using bounds test approach avoids the drawback of inability to test hypothesis associated with the estimated parameters caused by the endogeneity problem. Due to its numerous advantages over conventional cointegration techniques, the ARDL approach has become one of the most commonly used tools for researchers in recent years.

First step of the ARDL bounds test approach is to construct the Unrestricted Error Correction (UECM) forms of the models in question both with and without the trend variable. In this regard, the UECM representations of the models in Equation 3 and Equation 4 are presented with the Equation 5 and Equation 7 respectively. Additionally, Equation 6 and Equation 8 represents the trend included UECM forms of the models represented with Equation 3 and Equation 4 respectively. All the UECM forms includes the dummy variables for the structural break years which gathered from the findings of the Crash model of LS unit root test.

$$\Delta lo_t = \gamma_0 + \sum_{i=1}^{p_1} \gamma_{1i} \Delta lo_{t-i} + \sum_{i=0}^{q_1} \gamma_{2i} \Delta ly_{t-i} + \gamma_3 d_1 + \gamma_4 d_2 + \theta_{01} lo_{t-1} + \theta_{11} ly_{t-1} + \epsilon_{3t} \quad (1)$$

$$\Delta lo_t = \vartheta_0 + \sum_{i=1}^{p_2} \vartheta_{1i} \Delta lo_{t-i} + \sum_{i=0}^{q_2} \vartheta_{2i} \Delta ly_{t-i} + \vartheta_3 d_1 + \vartheta_4 d_2 + \vartheta_5 T + \theta_{02} lo_{t-1} + \theta_{12} ly_{t-1} + \epsilon_{4t} \quad (2)$$

$$\Delta ly_t = \sigma_0 + \sum_{i=1}^{p_3} \sigma_{1i} \Delta ly_{t-i} + \sum_{i=0}^{q_3} \sigma_{2i} \Delta lo_{t-i} + \sigma_3 d_1 + \sigma_4 d_2 + \theta_{03} ly_{t-1} + \theta_{13} lo_{t-1} + \epsilon_{5t} \quad (3)$$

$$\Delta ly_t = \omega_0 + \sum_{i=1}^{p_4} \omega_{1i} \Delta ly_{t-i} + \sum_{i=0}^{q_4} \omega_{2i} \Delta lo_{t-i} + \omega_3 d_1 + \omega_4 d_2 + \omega_5 T + \theta_{04} ly_{t-1} + \theta_{14} lo_{t-1} + \epsilon_{6t} \quad (4)$$

where Δ is the first lag operator, p_j 's and q_j 's denote appropriate lag lengths, d_j 's represent the dummy variables for the structural break years and T is the trend variable.

Having constructed the UECM forms, the models with appropriate lag lengths which are determined by using Akaike Information Criterion (AIC) or Schwarz Information Criterion (SIC) or Hannan-Quinn Information Criterion (HQ) or Adjusted R^2 (\bar{R}^2) criterion should be estimated. To check whether the selected model is best fitting, a series of diagnostics tests, namely, functional form test, serial correlation test, normality test and heteroscedasticity test should be employed. Moreover; stability tests, namely, cumulative sum of recursive residuals (CUSUM) and the cumulative sum squares of recursive residuals (CUSUMSQ) should be performed to test the parameter stability of the model over time.

The co-integration relationship among the variables should be investigated by the means of bounds test approach. In the bounds test procedure, the null hypothesis is $H_0: \theta_{0j} = \theta_{1j} = 0$, which suggests no cointegrating relation among the variables. This hypothesis needs to be tested against the alternative hypothesis, $H_1: \theta_{0j} \neq \theta_{1j} \neq 0$, for each UECM by using F and t tests. If the computed F and t statistics are less than the critical values of the lower bound, null hypothesis of no cointegration cannot be rejected. However, if the computed F and t statistics exceed the upper bound critical values, the null hypothesis of no cointegration should be rejected, concluding that the variables are cointegrated. On the other hand, if the computed F and t statistics fall within lower and upper critical values, the result is inconclusive implying that the ARDL technique is not applicable for investigating the cointegration relation between the variables.

Having detected the cointegration relationship between variables, the next step of the ARDL approach is to derive the long run coefficients from the UECM equations by using normalization procedure in which coefficients of the one period lagged terms of each independent variable is divided by the coefficient of the one period lagged term of the dependent variable. In the third step of the ARDL procedure, the restricted Error Correction Models (ECM) should be specified in order to capture the short run coefficients.

If the variables are found to be cointegrated, then the long run estimates of the ARDL model can be extracted from the UECM equations by normalizing θ_{1j} coefficients over θ_{0j} coefficients for each model. The short run parameters can also be obtained from the restricted Error Correction Models. However, the ARDL model still needs to be tested with diagnostics checks for normality, serial correlation heteroscedasticity and functional form. Moreover, to avoid the problem of the instability of the parameters cumulative sum of recursive residuals (CUSUM) test and the cumulative sum squares of recursive residuals (CUSUMSQ) test should be performed.

As proposed by Engle and Granger (1987), the existence of cointegration relationship implies that Granger (1969), causality must exist in at least one direction between the variables. Therefore, the possible short run causal

relations between the variables should also be investigated by using Granger non-causality approach. However, as criticized by [Toda and Yamamoto \(1995\)](#), the conventional Granger non-causality test results would be biased, if the variables are integrated of different order. In such cases, Toda-Yamamoto approach to Granger non-causality test should be used. One of the main advantages of Toda-Yamamoto test is that, the inclusion of the non-stationary variables at their levels allows to avoid information loss which occurs in conventional Granger non-causality test.

In the first step of the Toda-Yamamoto approach, the stationarity order of the series which has the highest degree of integration should be determined as the maximum order of integration (d_{max}). Following the first step, Unrestricted VAR model with the levels of the variables should be constructed and maximum appropriate lag length (p) of the unrestricted VAR model needs to be determined with the help of the most commonly used criteria like AIC, SIC, HQ.

In the third step, the augmented VAR model which includes additional lags (p) of each variable into each equation with the appropriate lag length of ($d_{max} + p$) should be specified. The adopted equations of the augmented VAR model which is proposed by [Toda and Yamamoto \(1995\)](#), are represented by Equation 9 and Equation 10.

$$lo_t = \zeta_0 + \sum_{i=1}^{d_{max}+p} \zeta_{1i} lo_{t-i} + \sum_{i=1}^{d_{max}+p} \zeta_{2i} yl_{t-i} + \zeta_3 d_1 + \zeta_4 d_2 + \zeta_5 T + \epsilon_{7t} \tag{5}$$

$$ly_t = \eta_0 + \sum_{i=1}^{d_{max}+p} \eta_{1i} lo_{t-i} + \sum_{i=1}^{d_{max}+p} \eta_{2i} ly_{t-i} + \eta_3 d_1 + \eta_4 d_2 + \eta_6 T + \epsilon_{8t} \tag{6}$$

After having established the augmented VAR model, the causal relations between the series should be analyzed by testing the null hypothesis, $H_0: \zeta_{ji} = 0$ for Equation 9 and $H_0: \eta_{ji} = 0$ for Equation 10, implying the absence of Granger causality, against the alternative hypothesis with the help of modified Wald statistics for each variable in the VAR system. It is essential to be sure of that the VAR is well-specified so that the VAR model is not suffering from problems such as serial correlation or heteroscedasticity.

5. Empirical Findings

5.1. Unit Root Tests

The results of the ADF unit root test which are presented in [Table 1](#), revealed that, oil is level stationary I (0) variable, while the income is integrated of first order I (1), according to both models with constant and constant and trend. The PP test results, both for the models with constant and constant and trend, verified the findings of the ADF unit root test. However, the results of the KPSS test which includes only constant suggested that both series are stationary in their first differences I(1). Moreover, if the trend variable is included, KPSS stationarity test results showed that income is stationary in its level form while oil is integrated of first order I(1).

Table-1. Findings of the Unit Root Tests with No Structural Breaks

| Test Type | ADF ^a | | | | PP ^b | | | | KPSS ^b | | | |
|-----------------|------------------|-------|-------------|-------|-----------------|-------|------------|-------|-------------------|------|------------|------|
| | C | | C+T | | C | | C+T | | C | | C+T | |
| lo | -6.80* (0) | | -4.85* (0) | | -7.31* (2) | | -5.03* (1) | | 0.81 (6) | | 0.23 (5) | |
| ly | -0.40 (0) | | -3.31 (3) | | -0.40 (2) | | -2.72 (0) | | 0.92 (6) | | 0.12** (5) | |
| Δlo | - | | - | | - | | - | | 0.64** (5) | | 0.20** (4) | |
| Δly | -4.86* (0) | | -3.74** (3) | | -4.98* (6) | | -4.65* (6) | | 0.06* (2) | | - | |
| Critical Values | %1 | %5 | %1 | %5 | %1 | %5 | %1 | %5 | %1 | %5 | %1 | %5 |
| | -3.55 | -2.91 | -4.13 | -3.49 | -3.55 | -2.91 | -4.13 | -3.49 | 0.46 | 0.73 | 0.14 | 0.21 |

^a Maximum lag length was chosen as 11 and the optimal lag lengths which are presented in parenthesis are determined by using AIC.

^b Bartlett kernel were used as spectral estimation method and the bandwidth was selected by using the Newey-West method both for the PP and KPSS tests.

C denotes intercept and C+T denotes intercept and trend.

* and ** denotes stationarity at 1% and 5% level respectively.

Although ADF, PP and KPSS stationarity tests are very popular among the researchers, in the case of structural break(s) the related tests suffer from spurious rejection. In order to avoid the spurious rejection problem, [Lee and Strazicizh \(2003\)](#), test which analyses the stationarity properties of the series by including two structural breaks was also used. Crash and Break model results of the LS unit root test with two structural breaks which presented in [Table 2](#) showed that both oil and GDP are stationary variables at their first differences I (1).

Table-2. Results of the Unit Root Tests with Structural Breaks

| Test Type | LS with Two Breaks ^a | | | |
|-----------------|---------------------------------|-------|--------------------|-------|
| | Crash | | Break | |
| lo | -1.65 [1982,1992] | | -4.00 [1977,1996] | |
| ly | -3.01 [1993,2010] | | -5.91 [1970,1999] | |
| Δlo | -5.44* [1972,1994] | | -7.07* [1975,1992] | |
| Δly | -6.32* [1970,1973] | | -6.96* [1970,1975] | |
| Critical Values | %1 | %5 | %1 | %5 |
| | -4.07 | -3.56 | -6.69 | -6.15 |

^a Maximum lag length was chosen as 8.

* and ** denotes stationarity at 1% and 5% level respectively.

The years in brackets are structural break years.

In summary, the findings of the unit root test results are conflicting. However, all unit root test results confirmed that none of the variables are stationary at their second differences I(2). Therefore, to investigate the dynamic relations between oil and income, ARDL bounds test approach is used.

5.2. ARDL Bounds Test Results

The dynamic relations between the oil consumption and economic growth are examined by using the ARDL models both with and without trend variable. The findings of the ARDL bounds test results are presented in Table 3.

Table-3. Bounds Test Results

| | <i>without trend</i> | | | | <i>with trend</i> | | | |
|--------------------------|----------------------|-------|----------------|-------|-------------------|-------|-----------------|-------|
| Model^a | ARDL (1,1) | | ARDL (1,1) | | ARDL (1,2) | | ARDL (2,1) | |
| F-statistics | F(lo ly)=27.85* | | F(ly lo)=1.54 | | F(lo ly)=14.26* | | F(ly lo)=6.18** | |
| Critical F Values | 1% | | 5% | | 1% | | 5% | |
| | I(0) | I(1) | I(0) | I(1) | I(0) | I(1) | I(0) | I(1) |
| | 6.84 | 7.84 | 4.94 | 5.73 | 6.56 | 7.30 | 8.74 | 9.63 |
| t-statistics | t(lo ly)=-4.69* | | t(ly lo)=-0.53 | | t(lo ly)=-5.23* | | t(ly lo)=-3.48 | |
| Critical t Values | 1% | | 5% | | 1% | | 5% | |
| | I(0) | I(1) | I(0) | I(1) | I(0) | I(1) | I(0) | I(1) |
| | -3.43 | -3.82 | -2.86 | -3.22 | -3.96 | -4.26 | -3.41 | -3.69 |

^a Appropriate lag length is chosen by using AIC.

* and ** denotes statistical significance at 1% and 5% level respectively.

Although the F statistics of ARDL (2,1) model for the relation ly|lo with trend is greater than the critical F value, the t-statistics of the same model falls within lower and upper bound critical values. Therefore, this model is eliminated to avoid inconsistent and biased results. Bounds test results presented in Table 3 revealed that the calculated statistics both for F and t tests exceed the upper bound critical value for ARDL (1,1) model for the relation lo|ly, without trend variable. However, this model was unable to pass diagnostic and stability checks. Thus, ARDL (1,1) model for the relation lo|ly is not used for further estimations as well.

ARDL (1,2) model, including the trend variable, in which both F and t statistics exceeding the upper bound critical values, has also passed both diagnostic and stability tests for the relation lo|ly. Therefore, it is found that there is a cointegration relation between the variables oil and GDP in the long run, where GDP is found to be the forcing variable for oil consumption.

5.3. Long Run Estimates of the ARDL Model

The long run parameter estimation results for ARDL (1,2) model with trend variable are presented in Table 4. The long-run results reveal that Real GDP is the key determinant for oil consumption and that the long run impact of Real GDP on oil consumption is positive. More importantly, the coefficient of the income is elastic and suggests that a 1% change in real income would lead to a 3.05% change in oil consumption in the same direction.

Table-4. Long Run Coefficients

| Variable | Coefficient | Standard Error | t-statistics | P-value |
|----------|-------------|----------------|--------------|---------|
| lny | 3.05 | 0.99 | 3.05 | 0.00* |

* and ** denotes statistical significance at 1% and 5% level respectively.

5.4. Short Run Estimates and Diagnostic Test Results

The results of the ECM form used for obtaining the short-run dynamics of the ARDL (2,1) model is provided in Table 5. The findings of the ECM model, suggested that all the variables with the exception of dummy variables are statistically significant at %5 level.

Table-5. Error Correction Representation

| Variable | Coefficient | t-statistics | P-value |
|-----------------------------|-------------|---------------|-------------|
| intercept | -10.56 | -5.34 | 0.00* |
| trend | -0.01 | -6.26 | 0.00* |
| Δy | 0.83 | 4.35 | 0.00* |
| Δy(-1) | -0.48 | -2.39 | 0.02** |
| d1982 | 0.03 | 0.56 | 0.57 |
| d1992 | 0.00 | 0.00 | 0.99 |
| ect(-1) | -0.15 | -5.39 | 0.00* |
| Important Statistics | | | |
| \bar{R}^2 | 0.63 | F-statistics | 13.62 |
| RSS | 0.14 | DW statistics | 2.04 |
| Diagnostic Tests | | | |
| χ^2_N | 3.13 (0.20) | χ^2_{SC} | 3.34 (0.50) |
| χ^2_{HS} | 2.79 (0.59) | χ^2_{MM} | 0.01 (0.88) |

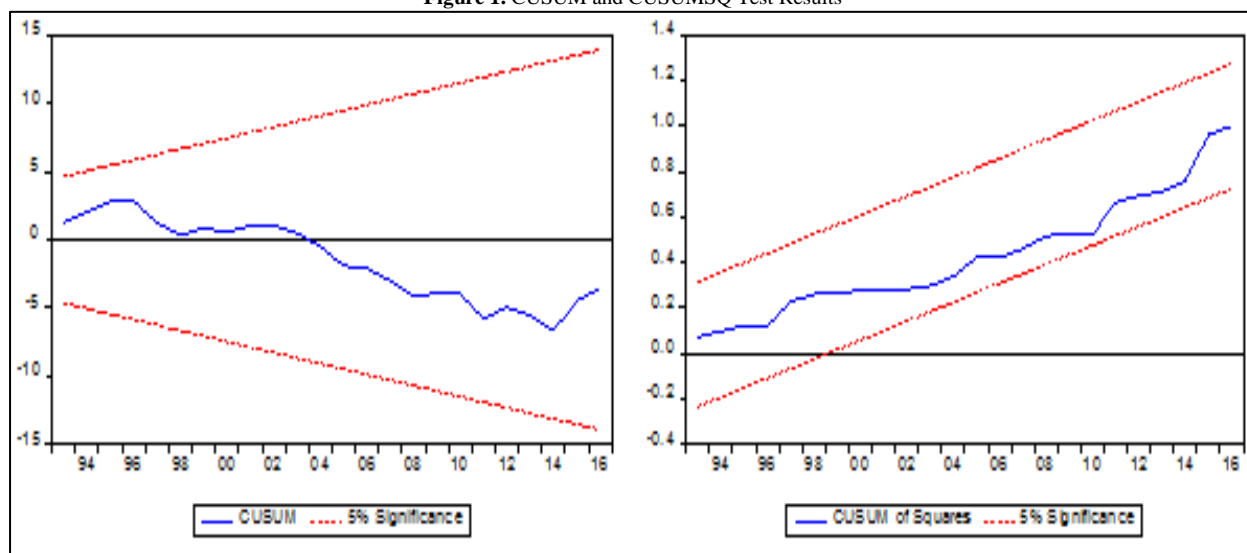
* and ** denotes statistical significance at 1% and 5% level respectively.

The coefficients of the variables Δy_t and Δy_{t-1} found to be positive and negative, respectively, which suggest that a one unit change in the current year's growth rate will cause a change in the oil consumption growth rate by 0.83 points in the same direction, while a change in the previous year's growth rate will cause a 0.48 points change in the current years oil consumption growth rate in the opposite direction.

The coefficient of the one period lagged error correction term (-0.15) is negative as expected and also statistically significant, which suggests that 15% of the deviations from the long-run equilibrium level of oil consumption will be corrected in the next period.

The ARDL (2,1) model is checked for normality with Jarque-Bera (χ^2_N) test, for serial correlation with Breusch-Godfrey LM (χ^2_{SC}) test, for heteroskedasticity with ARCH (χ^2_{HS}) test and for model misspecification with Ramsey RESET (χ^2_{MM}) test. According to the results in Table 5 the model successfully passed all diagnostic tests. The parameter stability of the model is also checked both with CUSUM and CUSUMSQ tests. The results of the CUSUM and CUSUMSQ tests are presented in Figure.1.

Figure 1. CUSUM and CUSUMSQ Test Results



As can be seen from Figure 1 the estimated parameters of the ARDL (2,1) model are stable according to both CUSUM and CUSUMSQ tests.

5.5. Toda-Yamamoto Causality Test

The causal relationship between the variables oil and real GDP is investigated by using Toda-Yamamoto procedure. The results of the Toda-Yamamoto test based upon the Equation 9 and Equation 10 are presented in Table 6.

Table-6. Toda-Yamamoto Causality Test Results

| Null Hypothesis | χ^2 | P-value | Decision |
|------------------------|-------------|---------------|--------------------|
| $y_t \nrightarrow o_t$ | 3.58 | 0.05** | H_0 Rejected |
| $o_t \nrightarrow y_t$ | 0.35 | 0.54 | H_0 Not Rejected |
| Diagnostic Tests | | | |
| χ^2_N | 3.12 (0.20) | χ^2_{SC} | 14.74 (0.67) |

^a The maximum lag length of the VAR Model is $s = 2$ which suggested by AIC and maximum order of integration is $d_{max} = 1$ suggested by LS unit test. Thus, the appropriate lag length of the VAR model is determined as $(d_{max} + p) = 3$.

^b There is no serial correlation or heteroskedasticity problem in the model.

* and ** denotes statistical significance at 1% and 5% level respectively.

According to the Toda-Yamamoto test results, the null hypothesis for equation 7 which suggests ly_t does not cause lo_t is rejected. However, the null hypothesis for the equation 8 which suggests lo_t does not cause ly_t cannot be rejected. Thus, the findings of the Toda and Yamamoto (1995), test revealed that there is a unidirectional causality running from real GDP to oil consumption, but not vice versa.

6. Conclusion

In this study, the dynamic relationship between oil consumption and income for the case of Turkey is investigated by using annual data over the period 1960-2016. Since the unit root test results were conflicting, ARDL approach to cointegration is employed. Bounds test results confirmed that there exists a cointegrating relation between oil consumption and economic growth, where economic growth found to be the long run forcing variable for oil consumption. The findings of the long run parameters of the model revealed that a 1% increase in Real GDP

would lead to a 3.05% increase in oil consumption. The parameter estimates of the error correction model showed that, 15% of the disequilibrium adjust back to the long run equilibrium within a year.

Apart from cointegration test, to uncover the direction of causality, Toda-Yamamoto version of Granger non-causality test is also employed. The results of the Toda-Yamamoto test showed that there exists a unidirectional causality running from economic growth to oil consumption which is consistent with the bounds test findings.

Both bounds test and Toda-Yamamoto test results suggested evidence in favor of the validity of conservation hypothesis for the case of Turkey over the period 1960-2016, which implies energy conservation policies will not harm economic growth in Turkey. Therefore, policy makers may take more brave steps to reduce the carbon footprint of Turkey without concerning about economic growth.

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