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TRADE LIBERALIZATION AND ENVIRONMENTAL DEGRADATION: A TIME SERIES ANALYSIS FOR TURKEY

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ABSTRACT

The relationship between trade liberalization and environmental degradation has become a popular issue in environmental economics in the last decades. In view of Turkey's position, as one of the main contributors to carbon dioxide (CO_2) emissions in Europe, it is vital to conduct a study to identify the main determinants of CO_2 emissions. This study investigates the causal relationship between CO_2 emissions (as a proxy of environmental degradation), trade openness, economic growth, energy consumption and foreign direct investment for the period 1974-2013. The long-run relationship is examined by the autoregressive distributed lag (ARDL) bounds testing approach to cointegration and error correction method (ECM). The results of the long model indicate that (i) the inverted U shape relationship between economic growth and CO_2 emissions exist, (ii) trade openness has positive impact on CO_2 emissions, (iii) foreign direct investment and energy consumption are positively related to CO_2 emissions.

Keywords: EKC hypothesis, CO_2 Emissions, Trade Openness, Foreign Direct Investment, ARDL Bounds Testing, Turkey

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1. INTRODUCTION

Although there is rapidly growing literature about the effect of trade on the environment, the answer is quite ambiguous. On one hand, some studies found evidences for the positive effects of trade liberalization on environment; on the other hand, some studies emphasized the harmful effects of trade liberalization on environment were dominant. Certainly, one part of the debate is sourced by different methodologies of the studies. For different pollutants, country or region, development level, estimators used, time interval and econometric methods, outcomes change as expected. Hence the empirical literature on trade and environment gives mixed results.

One approach of the supporters of trade liberalization based on Environmental Kuznets Curves (EKC). From Ricardian comparative advantage theory to Helpman-Krugman model of trade under imperfect competition it is widely accepted that openness has positive effects on countries' real income per capita. Antweiler et al. (2001) and Copeland and Taylor (2004) contributed to the literature by stating that increasing real income per capita impacts environmental quality in three different channels: *"Scale effect"* asserts increasing economic activity, ceteris paribus, causes increasing environmental degradation. *"Composition effect"* comprises structural change in the economy which means shift in production from manufacturing industry to knowledge intensive industries and service sector. Finally, *"Technological effect"* arises because of increasing environmental consciousness of the society and that's why increasing usage of eco-friendly technologies in production. EKC hypothesis states while in the first phases of development scale effect is dominant, after a certain level of per capita income composition and technological effects are being dominant and pollution trend will become reversed.

Another approach by Frankel and Rose (2005) made an important contribution to the debate by asserting openness could have a positive effect on environmental quality *even for a given level of GDP per capita* for three reasons: (i) trade may create managerial and technological innovation and these can have positive effects on both the economy and the environment. (ii) multinational corporations bring environment-friendly production techniques to the host countries. (iii) depending upon the rising public awareness, the international ratcheting up of environmental standards.

On the opposite side, many believe that openness harm to environment. It has been seen two popular approach within this side: race-to-bottom hypothesis and pollution havens. While the former claims countries that are open to trade tend to adopt looser environmental standards since they fear to lose their international competitiveness; the latter points out poor open countries adopts lax environmental standards both to attract foreign direct investment and to have a comparative advantage in pollution intensive industries.

In this study, we investigated the casual relationship between trade liberalization and environmental degradation in Turkey for the period 1974-2013. Trade liberalization is proxied by two variables: trade openness ratio and foreign direct investments. Environmental degradation is measured with CO_2 emissions per capita. We particularly focused on CO_2 emissions per capita in Turkey, since CO_2 is viewed to be the most important global pollutant contributing about 65% of the greenhouse gas emissions that causes global warming (IPCC, 2014) and Turkey is one of the biggest emitters of CO_2 within its region. According to World Development Indicators of the World Bank (2016), the share of Turkey in the total world CO_2 emissions was 0,17% in 1960 and 0,90% in 2013. In comparison to European Union, the share of CO_2 emissions of Turkey was 9,48% in 2013. Validity of EKC hypothesis is also checked within this study.

The remainder of this paper is organized as follows: Section 2 presents a brief literature review. Section 3 describes the models and the source of data samples that is used in the model. Section 4 presents the empirical results. Section 5 provides a conclusion.

2. LITERATURE REVIEW

Studies that put forward the relationship nexus economic growth follow the EKC hypothesis path. EKC hypothesis has been subject to many theoretical and empirical studies. Among these, three studies which have pioneering qualification can be mentioned as: Grossman and Krueger (1991, 1995), Shafik and Badyopadhyay (1992) and Panayotou (1993) who entitles the topic as EKC, found an inverted U relationship between a numerous pollutant and gross domestic product. In their seminal work, Grossman and Krueger (1991) studied whether the free trade between Mexico and the US leads to move polluted industries from the US to Mexico, the country with laxer environmental regulation, by estimating the EKC hypothesis for SO_2 and dark matter. In pursuit of these influential papers, there are numerous studies that points out U-shaped, N-shaped or monotonically increased relationship between different pollutants and economic growth.

Antweiler et al. (2001) found only small effects of trade on pollution concentrations; they also find relatively large impacts from changes in a nation's factor composition. Their estimates for SO_2 indicated that the elasticity of technical effect is greater than scale effect and trade induced composition had shown to have positive environmental consequences. Frankel and Rose (2005) suggested that trade openness reduces two measures of air pollution (SO_2 and NO_2) and does not seem to have detrimental effects on the other environmental indicators.

When we survey more recent studies that use panel estimations for country groups/regions or time series models for individual countries, we found quite similar results: while there is a positive relationship between trade openness and pollution for the developing countries, this trend tends to reverse for the developed countries.

Managi et al. (2009) studied the overall impact of trade openness on environmental quality and found out that whether trade has beneficial effect on the environment varies according to the pollutant and the country. Trade was found to be beneficial for SO_2 and CO_2 emissions in OECD countries although it had detrimental effects in non-OECD countries. Baek and Kim (2011), studied interrelationships between trade income growth energy consumption and CO_2 emissions for G-20 economies for the time span 1960-2006. The results indicated that trade and income growth have a favorable effect of environmental quality for the developed G-20 member countries while they have adverse effect on the environment for the developing countries. Similarly, E. Elmarzougui et al. (2016) investigated the impact of growth, trade and investment openness on the CO_2 and SO_2 emissions at the regional level for 1960-2007 period and they found mixed results for different regions and different pollutants. While the effects of FDI and domestic investments vary according to regional differences due to weak regulations in lower income countries; trade openness generally does not have a significant long run impact on emissions except OECD and South American countries. Le, Chang and Park (2016) found resembling conclusions for the particulate matter (PM10). They examined the relationship between the trade openness and the environment for 1990-2013 period and concluded that trade benefits the environment in high income countries but harms the environment in low-and-middle income countries.

Ang (2009) observed the Chinese pollution function using CO_2 emissions, GDP, energy use, trade openness for the period of 1953-2006. He has concluded that the increasing energy use, GDP and trade openness causes CO_2 emissions to augment. Halicioglu (2009) proposed the dynamic causal relationships between CO_2 emissions, GDP, energy consumption and foreign trade in Turkey over the period of 1960-2005. Their empirical results stated that income was the most significant variable in explaining the CO_2 emissions in Turkey which is followed by energy consumption and foreign trade. Jalil and Mahmud (2009) examined the long run relationship between CO_2 emissions and energy consumption, income and foreign trade for Chine over the period of 1975-2005. Their results supported EKC hypothesis and indicated that the CO_2 emissions are mainly determined by income and energy consumption in the long run. They also stated that trade had a positive but statistically insignificant impact on CO_2 emissions. Jayanthakumaran et al. (2012) assessed long and short run relationships between CO_2 emissions, growth, energy use, trade for both China and India over the period 1971-2007. They concluded that CO_2 emissions in China were determined by real GDP, energy consumption and structural changes. On the other hand, no causal relationship was detected for India. Acaravci and Ozturk (2013) examined the causal relationship between financial development, trade, economic growth, energy consumption and CO_2 emissions in Turkey for the period of 1960-2007. They found a positive relationship between trade openness and no significant effect of financial development on per capita carbon emissions in the long run. Also, their results supported the validity of EKC hypothesis. Shahbaz et al. (2013) presented the linkages among economic growth, energy consumption, financial development, trade openness and CO_2 emissions over the period 1975-2011 in case of Indonesia. Their empirical findings indicated that economic growth and energy consumption increase CO_2 emissions, while financial development and trade openness compact it. Lau et al. (2014) examined the EKC hypothesis for Malaysia in the present of both FDI and trade openness for the period 1970-2008. Their results indicated that EKC hypothesis existed and both FDI and trade openness had positive relationship with CO_2. Farhani and Ozturk (2015) studied the casual relationship between CO_2 emissions, real GDP, energy consumption, financial development, trade openness and urbanization in Tunisia over the period of 1971-2012. They have explored a positive monotonic relationship between CO_2 emissions per capita and real GDP per capita which rejected the validity of EKC hypothesis. Additionally, the long run estimates of CO_2 emissions per capita with respect to energy consumption per capita, financial development, trade openness and urbanization were positive. Akomolafe et al. (2015) analyzed the relationship between trade openness, economic growth, urbanization/ruralization and environmental pollution proxied by per capita CO_2 emissions in Nigeria for the 1960-2010 period. They came up with the relationship between trade openness and pollution is negative in the short run though positive in the long run. However, they emphasized that among all the independent variables trade openness has the least influence on pollution. The existence of EKC in Nigeria was confirmed. Halicioglu and Ketenci (2016) presented the impact of international trade on environmental quality for the transition countries over the period 1991-2013. They concluded that EKC hypothesis was valid for only three transition countries (Estonia, Turkmenistan and Uzbekistan) and the impact of trade on environmental quality (proxied by CO_2 emissions) in the breakaway countries of the Soviet Union varies according to their development level terms.

3. DATA AND MODEL SPECIFICATION

This study covers annual frequency data over the period of 1974-2013 for Turkey. The data on CO_2 emissions (CO2, in metric tons per capita), energy consumption (EC, in kg of oil equivalent per capita), foreign direct investments (FDI, net inflows to Turkey, in current US$), Gross Domestic Product per capita (GDPPC, in current US$) and trade openness (OPENNESS, measured as the sum of exports and imports as a share of GDP) are collected from World Development Indicators of the Worldbank (2016).

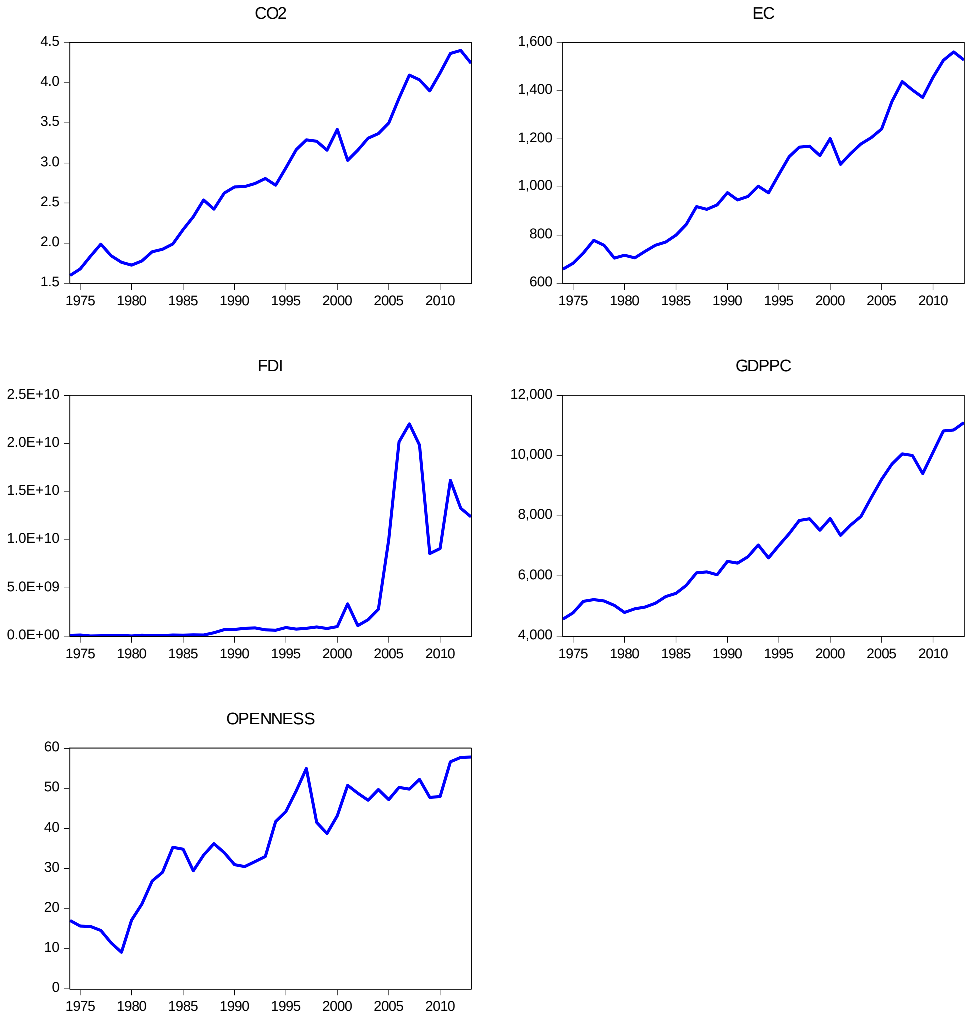

Fig. 1. CO_2, EC, FDI, GDPPC and OPENNESS times series of Turkey for the period 1974-2013.

Time series of the variables used in the empirical analysis are presented in Figure 1. It is seen obviously that all variables (except FDI) have an exponential increase slightly. It must be emphasized that depending upon the financial liberalization in Turkey in late 1980s, it is observed a boom in FDI inflows.

Table 1
Descriptive Statistics.

	CO_2	EC	FDI	GDPPC	OPENNESS
Mean	2.8587	1039.8840	3.78E+09	7150.0080	37.1027
Median	2.7748	989.7650	7.53E+08	6823.5670	37.4663
Maximum	4.4029	1561.835	2.20E+10	11102.2900	57.8147
Minimum	1.5973	658.5218	10000000	4560.0080	9.0997
Std. Dev.	0.8493	270.6413	6.40E+09	1965.6310	13.9996
Skewness	0.1989	0.3547	1.7326	0.5182	-0.3925
Kurtosis	1.9198	1.9917	4.6280	2.0970	2.0705
Observations	40	40	40	40	40

CO_2: Metric tons per capita.
EC: Kg of oil equivalent per capita.
FDI: Net inflows, BoP, current US$.
OPENNESS: (EX+IM)/GDP.
GDPPC: Current US$.

Table 2
Correlation coefficient matrix.

	CO_2	EC	FDI	GDPPC	OPENNESS
CO_2	1				
EC	0.9969***	1			
FDI	0.7644***	0.7816***	1		
GDPPC	0.9872***	0.9937***	0.8185***	1	
OPENNESS	0.9056***	0.8951***	0.6035***	0.8745***	1

*** Indicate significance level at 1% levels.

Table 1 provides the descriptive statistics of the variables. In Table 2 the correlation matrix is for the variables is presented. According to Table 2, EC, FDI, GDPPC and OPENNESS are positively correlated to CO_2 emissions and significant at 1% level.

3.1. Model Specification

After examining the time series plot of the variables and in the light of the extensive literature about the topic, the following model is specified:

$$CO_2 = \beta_0 EC^{\beta_1} FDI^{\beta_2} GDPPC^{\beta_3} OPENNESS^{\beta_4} \quad (1)$$

For the purpose of linearity, the model is converted into natural logarithm in Eq. (2) In this way, both stationarity of the variables is ensured as well as the coefficients of the model can be used for the elasticity interpretation.

$$LNCO_2 = \beta_0 + \beta_1 LNEC + \beta_2 LNFDI + \beta_3 LNGDPPC + \beta_4 LNOPENNESS \quad (2)$$

To check the validity of the EKC hypothesis, the squared GDPPC variable is also added to Eq. (2). Hence the model is constructed as follows:

$$LNCO_{2t} = \beta_0 + \beta_1 LNEC_t + \beta_2 LNFDI_t + \beta_3 LNGDPPC_t + \beta_4 LNGDPPC^2{}_t + \beta_5 LNOPENNES_t + \varepsilon_t (3)$$

where β_1, β_2, β_3 and β_5 represent the long-run elasticities of the related variables, ε_t is the regression error term.

The expected signs for the parameters in Eq. (3) are as follows: $\beta_1>0$, $\beta_3>0$, $\beta_4<0$. For β_2 and β_5 it is difficult to predict their signs. They can be either positive of negative. It is obvious that $\beta_1>0$ because the reason behind the increasing energy consumption is the increasing economic activity and it simply causes pollution. β_3 and β_4 are the coefficients of GDPPC and $GDPPC^2$. Under the EKC hypothesis the signs are expected positive and negative respectively. If only β_4 is statistically insignificant, it implies there is a monotonically increasing relationship between CO_2 emissions and GDPPC. The coefficient of the FDI, β_2, may be positive or negative. Some economists suggest FDI contributes to economic growth and accordingly environmental degradation (Xing and Kolstad, 2002; Zhang, 2011; Lau et el, 2014). On the other hand, some economists emphasize that FDI brings environment-friendly production techniques to the host countries and contributes that environmental quality improves. (List and Co, 2000; Frankel and Rose, 2005; Tamazian et al., 2009) Similarly, the expected sign of β_5 is ambiguous and depends on the development level of the country. As explained before, Antweiler et al. (2001) and Copeland and Taylor (2004) proposed that trade (or any other determinants of real GDP) impact environmental quality with three channels: scale (size of economy), composition (specialization) and technique (production methods). For the developing countries scale effect is dominant, then it can be expected $\beta_5>0$. However, composition and technological effects are being dominant and pollution trend will become reversed for developed countries, therefore $\beta_5<0$.

3.2. Bounds Testing Approach for Cointegration

ARDL technique proposed by Pesaran et al. (2001) is used for the estimation of the CO_2 emission model. The ARDL model is a good technique to examine the existence of a long run relationship between variables in levels or regardless whether the variables are I(0) or I(1). Pesaran et al.'s ARDL technique, which allows building model with variables in different levels, based on a cointegration analysis. This cointegration analysis is also known as bounds testing.

An ARDL model representation is as follows:

$$\Delta \mathrm{LNCO_2}_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1i}\Delta \mathrm{LNCO_2}_{t-i} + \sum_{i=0}^{n} \alpha_{2i}\Delta \mathrm{LNEC}_{t-i} + \sum_{i=0}^{n} \alpha_{3i}\Delta \mathrm{LNFDI}_{t-i} + \sum_{i=0}^{n} \alpha_{4i}\Delta \mathrm{LNGDPPC}_{t-i} + \sum_{i=0}^{n} \alpha_{5i}\Delta \mathrm{LNGDPPC^2}_{t-i} + \sum_{i=0}^{n} \alpha_{6i}\Delta \mathrm{LNOPENNESS}_{t-i} + \alpha_7 \mathrm{LNCO_2}_{t-1} + \alpha_8 \mathrm{LNFDI}_{t-1} + \alpha_9 \mathrm{LNGDPPC}_{t-1} + \alpha_{10}\mathrm{LNGDPPC}^2_{t-1} + \alpha_{11}\mathrm{LNOPENNESS}_{t-1} + u_t \quad (4)$$

where Δ is the difference operator and u_t is white noise error terms. The joint significance of the lagged levels in this equation has examined by the F-test. The joint significance test that implies no cointegration is expressed H_0: $\alpha_7 = \alpha_8 = \alpha_9 = \alpha_{10} = \alpha_{11}=0$ against H_1: at least one of them is different from zero. The F-test is used for this procedure. Pesaran et al. (2001) computed critical values for I(0) and I(1) for given significance levels with and without time trend. After establishing long-run model, the lags of the model are determined with several model selection criteria.

To examine the short-term relationship eq. (4) is modified as follows:

$$\Delta \mathrm{LNCO_2}_t = \gamma_0 + \sum_{i=1}^{n} \gamma_{1i}\Delta \mathrm{LNCO_2}_{t-i} + \sum_{i=0}^{n} \gamma_{2i}\Delta \mathrm{LNEC}_{t-i} + \sum_{i=0}^{n} \gamma_{3i}\Delta \mathrm{LNFDI}_{t-i} + \sum_{i=0}^{n} \gamma_{4i}\Delta \mathrm{LNGDPPC}_{t-i} + \sum_{i=0}^{n} \gamma_{5i}\Delta \mathrm{LNGDPPC^2}_{t-i} + \sum_{i=0}^{n} \gamma_{6i}\Delta \mathrm{LNOPENNESS}_{t-i} + \lambda ec_{t-1} + v_t \quad (5)$$

where λ is the adjustment parameter and ec_{t-1} is the residuals obtained from the estimated cointegration model of eq. (3) and it is also known as cointegration coefficient.

4. EMPIRICAL RESULTS

The results of Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests are represented in Table 3. Both tests demonstrate that all series except FDI are non-stationary at their levels. As it can be seen that all series are stationary at their first difference, therefore they are I(1).

Table 3
Unit root tests.

Variable/Test	ADF		PP	
	Level	First Difference	Level	First Difference
$LNCO_2$	-2.6571	-5.2049***	-2.7892	-5.2021***
LNEC	-3.0521	-5.2901***	-3.1770	-5.2877***
LNFDI	-4.3435***	-8.6449***	-4.3435***	-9.4466***
LNGDPPC	-2.6883	-5.0460***	-2.7846	-5.0931***
LNOPENNESS	-2.1305	-5.3149***	-2.3246	-5.2728***

*** Denote the rejection of the null hypothesis at 1% levels of significance. The null hypothesis for ADF and PP is that series has unit root. The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) critical values are based on McKinnon. The optimal lag is chosen on the basis on Schwarz Info Criterion (SIC). Trend and intercept are included in all test equations.

Table 4 shows the computed F-statistics exceeds upper critical bounds values for each model selection criteria. Therefore, according to computed F-statistics we reject the null hypothesis of no cointegration for Eq. (4). Among these models SIC (1, 1, 0, 0, 0, 0) ARDL model is chosen. The lag length of this model hereafter be used is also the same with the lag length of the unrestricted VAR model. The optimal lag length is also found to be 1 for all lag length criteria in unrestricted VAR model. The results are not shown here for simplicity.

Table 4
The Bound tests results.

Order of ARDL		F-Statistic	
AIC (2, 1, 2, 0, 2, 1)		5.61230	
SIC (1, 1, 0, 0, 0, 0)		4.1715	
HQ (2, 0, 2, 0, 2, 1)		21.718	
$\overline{R}_2$ (2, 1, 2, 0, 2, 1)		5.6123	
Pesaran et al. $(2001)^a$			
Significance	I (0)	I (1)	
10%	2.26	3.35	
5%	2.62	3.79	
2.5%	2.96	4.18	
1%	3.41	4.68	

[a] Critical values obtained from Pesaran et al. (2001), Case III: Unrestricted intercept and no trend.

The long run model estimates for SIC (1, 1, 0, 0, 0, 0) ARDL model is shown in Table 5. The coefficients of the model also make it possible to interpret elasticities. The long run elasticity estimates of CO_2 emissions per capita with respect to energy consumption per capita is expected. 1% percentage increase in energy consumption per capita increases CO_2 emissions by 1.0561%. In addition, this estimated coefficient is significant at 1% level. Under the EKC hypothesis, the long run elasticity estimates of CO_2 emissions per capita with respect to GDPPC and the square of GDPPC are 5.9997 and -0.3399 respectively. 1 % increase in GDPPC increases CO_2 emissions per capita by 5.9997%. The signs of these variables are as expected also. These signs support the validity of EKC hypothesis in Turkish economy. The graphical representation of CO_2 emissions with respect to GDPPC and square of GDPPC can be seen in Fig. 2.

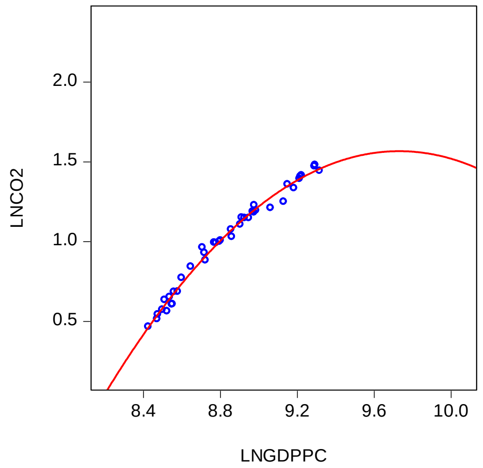

Fig.2. Scatter plot of CO_2 emission and GDPPC with a fitted quadratic function.

The long run elasticity estimates of CO_2 emissions per capita with respect to FDI is 0.0216 and significant at 10% levels of significance. In the light of this regression output, it is acceptable to interpret as FDI has a small impact on CO_2 emissions because 1% increase in FDI increase CO_2 emissions only by 0.0126%. Finally, the coefficient of OPENNESS sign is as expected but it is not significant. Subject to 1974-2013 period for Turkish economy, a statistical proof could not be found to fortify this relation for inference.

Table 5

Long-run model with unrestricted constant and no trend, SIC (1, 1, 0, 0, 0, 0).

Dependent Variable: $LNCO_2$.

Variable	Coefficient	Std. Error	t-Statistic
LNEC	1.0561	0.1898	5.5621***
LNGDPPC	5.9997	1.4654	4.0941***
$LNGDPPC^2$	-0.3399	0.0773	-4.3973 ***
LNFDI	0.0126	0.0067	1.8729 *
LNOPENNESS	0.0226	0.0186	1.2168

*** Denote the rejection of the null hypothesis at 1% levels of significance.
** Denote the rejection of the null hypothesis at 5% levels of significance.
* Denote the rejection of the null hypothesis at 10% levels of significance.

Checking the regression analysis assumptions, it can be concluded that the model is adequate. Because it passes basic diagnostic tests such as Jarque-Bera test for normality assumption, Breusch-Godfrey test for serial correlation, White test for heteroscedasticity and at last Ramsey-Reset test for model specification. Table 6 gives the results of these tests discussed above. In addition, Fig.3 in appendix given for CUSUM and CUSUM squares tests to emphasize the stability of the coefficients.

Table 6
Residual diagnostic tests for $LNCO_2$ long-run model.

Diagnostic test	Null hypothesis (H_0)	Statistics	Decision
Jarque-Bera	Error terms are normally distributed	1.1227 [0.5704]	Fail to reject H_0
Breusch-Godfrey	No autocorrelation in error terms	0.3277 [0.7231]	Fail to reject H_0
White	Error terms are homoscedastic	1.8559 [0.1082]	Fail to reject H_0
Ramsey Reset	The model is correctly specified	2.5512 [0.1204]	Fail to reject H_0

Note: Figures in brackets represent probability values of the test statistics

In the short run model, the estimated cointegration coefficient (ec_{t-1}) sign is as expected as negative and the value is -0.7777. It is also significant at 1% levels of significance. The sign of this coefficient reflects the cointegration between variables. According to this coefficient, 0.7777% of the discrepancy between the short-run and the long run will be closed within the next year.

Table 7
Short-run model with unrestricted constant and no trend, SIC (1, 1, 0, 0, 0, 0).
Dependent Variable: D($LNCO_2$).

Variable	Coefficient	Std. Error	t-Statistic
C	-25.73148	4.7834	-5.3793 ***
D(LNEC)	1.15902	0.0688	16.8318 ***
${ec_{t-1}}^a$	-0.7777	0.1445	-5.3796 ***

*** Denote the rejection of the null hypothesis at 1% levels of significance.
$^a ec_{t-1} = \mathrm{LNCO2} - (1.056\mathrm{LNEC} + 5.999\mathrm{LNGDPPC} - 0.339\mathrm{LNGDPPC}^2 + 0.012\mathrm{LNFDI} + 0.0226\mathrm{LNOPENNESS}$

5. CONCLUSION

This paper has attempted to analyze the causal relationship between CO_2 emissions, trade openness, economic growth, energy consumption and foreign direct investment in Turkey over the period 1974-2013. For this purpose, it is applied the ARDL bounds testing approach to examine the cointegration among the variables and found evidence of a long run relationship between per capita CO_2 emissions, per capita energy consumption, per capita GDP, the square of per capita GDP and foreign direct investments. The empirical results support the validity of EKC hypothesis in Turkey for the chosen period. Therefore, CO_2 emissions initially increases with GDP per capita, then it declines in Turkey. The long run elasticities of CO_2 emissions with respect to GDP per capita, energy consumption, and foreign direct investment are (5.99), (1,06) and (0,01) respectively. Compatible with Halicioglu (2009) and Ozturk and Acaravci (2013), GDP per capita is the most important variable in explaining CO_2 emissions in Turkey which is followed by energy consumption. Interestingly, although the empirical results suggest a small but positive relationship between trade openness and CO_2 emissions, it is statistically insignificant in the long-run. Therefore, in 1974-2013 period for Turkish economy, a statistical proof could not be found to fortify this relation for inference.

As Halicioglu (2009) indicated, it is obvious that Turkey's energy policy should be reconsidered to reduce the environmental degradation. Our results suggest that CO_2 emissions can be reduced at the cost of economic growth or the structure of energy consumption in Turkey must be converted to more environment friendly and renewable energy sources. In this sense decreasing energy intensity or increasing energy efficiency is only possible with alternative policy projections. Moreover, to promote the producers who uses green technologies with market-based environmental policy instruments and to encourage the import of green technologies may help to solve the problem.

APPENDIX

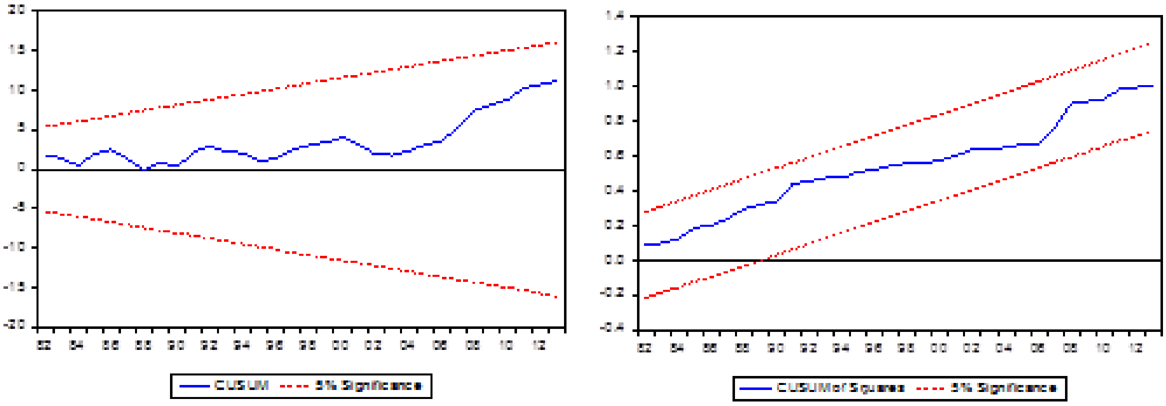

Fig. 3. Plot of CUSUM and CUSUM of squares tests for the $LNCO_2$ long-run model.

REFERENCES

Akomolafe, K. J. – J. D. Danladi – Y. R. Oseni (2015), *"Trade Openness, Economic Growth, and Environmental Concern in Nigeria"*, **International Journal of African and Asian Studies**, Vol. 13, pp. 163-171.

Ang, J. B. (2009), *"CO2 emissions, research and technology transfer in China"*, **Ecological Economics**, Vol. 68, pp. 2568-2665.

Antweiler, W. – B. R. Copeland – M. S. Taylor (2001), *"Is Free Trade Good for the Environment"*, **American Economic Review**, Vol. 91(4), pp. 877-908.

Baek, J. and H. S. Kim (2011), *"Trade Liberalization, Economic Growth, Energy Consumption and the Environment: Time Series Evidence from G-20 Economies"*, **Journal of East Asian Economic Integration**, Vol. 15(1), pp. 3-32.

Copeland, B. R. – M. S. Taylor (2004), *"Trade, Growth and Environment"*, **Journal of Economic Literature**, Vol. 42, pp. 7-71.

Elmarzougui, E. – B. Larue – L. D. Tamini (2016), *"Trade Openness, Domestic and Foreign Investments, and the Environment"*, **Modern Economy**, Vol. 7, pp. 591-605.

Farhani, S. and I. Ozturk (2015), *"Causal relationship between CO2 emissions, real GDP, energy consumption, financial development, trade openness, and urbanization in Tunisia"*, **Environmental Science and Pollution Research,** Vol. *22*, pp. 15663-15676.

Frankel, J. A. and A. K. Rose (2005), *"Is Trade Good or Bad for the Environment? Sorting out the Causality"*, **The Review of Economics and Statistics**, Vol. 87(1), pp. 85-91.

Grossman, G.M. and A. B. Kruger (1991), *"Environmental Impacts of the North American Free Trade Agreement"*, **NBER Working Paper**, No: 3914.

Grossman, G.M. and A.B. Krueger (1995), *"Economic Growth and the Environment"*, **Quarterly Journal of Economics**, Vol. 110 (2), pp. 353–377.

Halicioglu, F. (2009), *"An Econometric Study of CO2emissions, Energy Consumption, Income and Foreign Trade in Turkey"*, **Energy Policy**, Vol. 37(3), pp. 1156–1164.

Halicioglu, F. And N. Ketenci (2016), *"The impact of international trade on environmental quality: The case of transition countries"*, **Energy**, Vol. 109, pp. 1130-1138.

IPCC (2014), **Climate Change 2014: Impacts, Adaptation, and Vulnerability**, Cambridge University Press.

Jalil, A. and S. F. Mahmud (2009), *"Environment Kuznets curve for CO2 emissions: A cointegration analysis for China"*, **Energy Policy**, Vol. 37, pp. 5167-5172.

Jayanthakumaran, K. – R. Verma – Y. Liu (2012), *"CO2 emissions, energy consumption, trade and income: A comparative analysis of China and India"*, **Energy Policy**, Vol. 42, pp. 450-460.

Lau, L. S. – C. K. Choong – Y. K. Eng (2014), *"Investigation of the environmental Kuznets curve for carbon emissions in Malaysia: Do foreign direct investment and trade matter?"*, **Energy Policy**, Vol. 68, pp. 490-497.

Le, T. H – Y. Chang – D. Park (2016), *"Trade openness and environmental quality: International evidence"*, **Energy Policy**, Vol. 92, pp. 45-55.

List, J. and C. Y. Co (2000), "*The effect of environmental regulation on foreign direct investment*", **Journal of Environmental Economics and Management**, Vol. 40(1), pp. 1–40

Managi, S. – A. Hibiki – T. Tsurumi (2009), *"Does trade openness improve environmental quality?"*, **Journal of Environmental Economics and Management**, Vol. 58, pp. 346-363.

Ozturk, I. and A. Acaravci (2013), *"The long-run and causal analysis of energy, growth, openness and financial development on carbon emissions in Turkey"*, *Energy Economics*, Vol. 36, pp. 262-267.

Panayotou, T. (1993), *"Empirical Tests and Policy Analysis of Environmental Degradation at Different Stages of Economic Development"*, **ILO Technology and Employment Program Working Paper**, No: WP238.

Pesaran, M.H. – Y. Shin – R. Smith (2001), "*Bounds testing approaches to the analysis of level relationships*", **Journal of Applied Econometrics**, Vol. 16(3), pp. 289–326.

Shafik, N. and S. Bandyopadhyay (1992), *"Economic Growth and Environmental Quality: Time Series and Cross-Country Evidence"*, **Background Paper for World Development Report 1992**, World Bank, Washington DC.

Shahbaz, A. – Q. M. A. Hye – A. K. Tiwari – C. Leitao (2013), *"Economic growth, energy consumption, financial development, international trade and CO2 emissions in Indonesia"*, **Renewable and Sustainable Energy Reviews**, Vol. 25, pp. 109-121.

Tamazian, A. – J. P. Chousa – C. Vadlamannati (2009), “*Does higher economic and financial growth lead to environmental degradation: evidence from the BRIC countries*”, **Energy Policy**, Vol. 37(1), pp. 246–253.

The Worldbank (2016), World Development Indicators, available online at http://databank.worldbank.org/data/download/archive/WDI_excel_2015_12.zip [24/07/2017]

Xing, Y. and C. D. Kolstad (2002), “*Do lax environmental regulation attract foreign investment?*”, **Environmental and Resource Economics**, Vol. 21(1), pp. 1-22.

Zhang, Y. J. (2011), “*The impact of financial growth on carbon emissions: an empirical analysis in China*”, **Energy Policy**, Vol. 39(4), pp. 2197–2203.