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

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Abstract

The relationship between trade liberalization and environmental degradation is becoming an increasingly popular issue in environmental economics in recent 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 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 with 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 a positive but insignificant impact on CO_2 emissions, and (iii) foreign direct investment and energy consumption have a direct relationship with CO_2 emissions.

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

INTRODUCTION

Although there is abundant research about the effects of trade on the environment, the findings vary greatly. While some studies have found evidence for the positive effects of trade liberalization on the environment, other studies have argued that trade liberalization further harms the environment. Certainly, one part of the debate can be related to different methodologies of the studies. Results of the studies vary depending on different pollutants, country or region, development level, estimators used, time interval and econometric methods. Hence, empirical research on trade and environment yields mixed results.

One approach of the supporters of trade liberalization is based on the Environmental Kuznets Curves (EKC). From Ricardian comparative advantage theory to the 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 ways. First of all, the *"Scale Effect"* asserts increasing economic activity, *ceteris paribus*, which causes increased environmental degradation. Secondly, the *"Composition Effect"* comprises a structural change in the economy, or a shift in production from industrial manufacturing to knowledge intensive industries and the service sector. Finally, there is the *"Technological Effect,"* resulting from increasing environmental consciousness; this manifest itself in an increasing usage of eco-friendly technologies in production. The EKC hypothesis states that in initial phases of economic development the Scale Effect is dominant. After crossing a threshold of per capita income, the Composition and Technological Effects become more dominant, resulting in a reversal of pollution trends.

Another approach by Frankel and Rose (2005) made an important contribution to the debate by asserting that trade 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 innovations resulting in positive effects on the economy and the environment. (ii) Multinational corporations bring environmentally friendly production techniques to the host countries. (iii) International environmental standards improve in correlation with an increase in public awareness.

Conversely, many believe that openness to trade harms the environment. Two common approaches can be easily observed: the race-to-the-bottom hypothesis and pollution havens. The former claims that countries open to trade tend to adopt looser environmental standards, fearing the loss of international competitiveness. The latter highlights lax environmental

standards in developing countries with open trade policies, in order to both attract foreign direct investment and to have an advantage in pollution intensive industries.

In this study, we investigated the causal relationship between trade liberalization and environmental degradation from 1974-2013 in Turkey. Trade liberalization was proxied by two variables: trade openness ratio and foreign direct investments. Environmental degradation was measured with CO_2 emissions per capita. As CO_2 is the most significant global pollutant, contributing about 65% of global warming causing greenhouse gas emissions (IPCC, 2014), and considering Turkey's role as one of the biggest contributors of CO_2 emissions within its region, our primary focus in this study was CO_2 emissions per capita in Turkey. According to World Development Indicators of the World Bank (2016), Turkey's contribution to global CO_2 emissions was 0,17% in 1960 and 0,90% in 2013. Turkey's contribution to European Union CO_2 emissions, in comparison, was 9,48% in 2013. Also examined in this study was the validity of the EKC hypothesis.

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

LITERATURE REVIEW

Studies that put forward the environmental degradation and economic growth nexus follow the EKC hypothesis path. The EKC hypothesis has been the focus of many theoretical and empirical studies. Three influential studies have been done by Grossman and Krueger (1991, 1995), Shafik and Badyopadhyay (1992) and Panayotou (1993). Panayotou, to whom we can accredit the term EKC, found an inverted U relationship between numerous pollutants and gross domestic product. In their seminal work, Grossman and Krueger (1991) studied whether free trade between Mexico and the USA leads to move polluted industries from the USA to Mexico, where environmental standards are laxer, by estimating the EKC hypothesis for SO_2 and dark matter. Following these influential papers, there have been numerous studies that point out U-shaped, N-shaped or monotonically increased relationships between different pollutants and economic growth.

Antweiler et al. (2001) found only small effects of trade on pollution concentrations; they also found relatively large impacts from changes in a nation's factor composition. Their estimates for SO_2 indicated that the elasticity of the Technical Effect is greater than the Scale Effect, and trade-induced composition was shown to have positive environmental consequences. Frankel and Rose (2005) suggested that trade openness reduces emissions

from two air pollutants (SO_2 and NO_2) and does not seem to have detrimental effects on other environmental indicators.

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

Managi et al. (2009) studied the overall impact of trade openness on environmental quality and discovered that the beneficial effects of trade on the environment vary depending on the pollutant and the country. Trade was found to be beneficial for SO_2 and CO_2 emissions in OECD countries, while having 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 from 1960-2006. Their results indicate that trade and income growth have a favorable effect on environmental quality for developed G-20 member countries while they have adverse effects on environments in 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 from 1960-2007, and, similarly, the results varied depending on region and pollutant. While the effects of foreign 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, with the exception of OECD and South American countries. Le, Chang and Park (2016) had similar findings for particulate matter (PM10). They examined the relationship between trade openness and the environment from 1990-2013 and concluded that trade benefits the environment in high income countries but harms the environment in low and middle-income countries.

Ang (2009) examined the Chinese pollution function using CO_2 emissions, GDP, energy use, trade openness from 1953-2006. He concluded that increased energy use, GDP and trade openness causes CO_2 emissions to rise. Halicioglu (2009) proposed a dynamic causal relationship between CO_2 emissions, GDP, energy consumption and foreign trade in Turkey from 1960-2005. His empirical results state that income was the most significant variable in explaining CO_2 emissions in Turkey, 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 in China from 1975-2005. Their results supported the EKC hypothesis and indicated that CO_2 emissions are determined primarily by income and energy consumption. 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 from 1971-2007. While they concluded that CO_2 emissions in China were determined by real GDP, energy consumption and structural changes, 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 from 1960-2007. They found a positive relationship between trade openness and long run per capita carbon emissions, while the effects from financial development were insignificant. Their results supported the validity of the EKC hypothesis. Shahbaz et al. (2013) discovered connections between economic growth, energy consumption, financial development, trade openness and CO_2 emissions from 1975-2011 in the case of Indonesia. Their empirical findings indicated that economic growth and energy consumption result in increased CO_2 emissions, while financial development and trade openness resulted in a decrease of emissions. Lau et al. (2014) examined the EKC hypothesis for Malaysia in the presence of both FDI and trade openness from 1970-2008. Their results indicated that the EKC hypothesis was relevant and both FDI and trade openness had a direct relationship with CO_2 emissions. Farhani and Ozturk (2015) studied the causal relationship between CO_2 emissions, real GDP, energy consumption, financial development, trade openness and urbanization in Tunisia from 1971-2012. They found a positive monotonic relationship between CO_2 emissions per capita and real GDP per capita, thus rejecting the validity of the EKC hypothesis. Additionally, the long run estimates of CO_2 emissions per capita were positive, with respect to per capita energy consumption, financial development, trade openness and urbanization. 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 from 1960-2010. They concluded that in the short run there is no relationship between trade openness and CO_2 emissions, though trade openness and pollution had a direct relationship in the long run. However, they emphasized that among all the independent variables, trade openness has the least influence on pollution. The validity of EKC in Nigeria was confirmed. Halicioglu and Ketenci (2016) presented the impact of international trade on environmental quality for the transition countries from 1991-2013. They concluded that the 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 states from the Soviet Union varies according to development level.

METHODOLOGY

The Data

Long historical data on pollution for Turkey are not available from any domestic official source. Therefore, we have obtained the data from Worldbank. Although the other series are available continuously from 1960, data for Foreign Direct Investments are only available from 1974. Therefore this study analyses Turkey's annual frequency data from 1974-2013 which is the maximum available length for the selected variables. The data on CO_2 emissions (CO_2, 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 USD), Gross Domestic Product per capita (GDPPC, in real USD) 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).
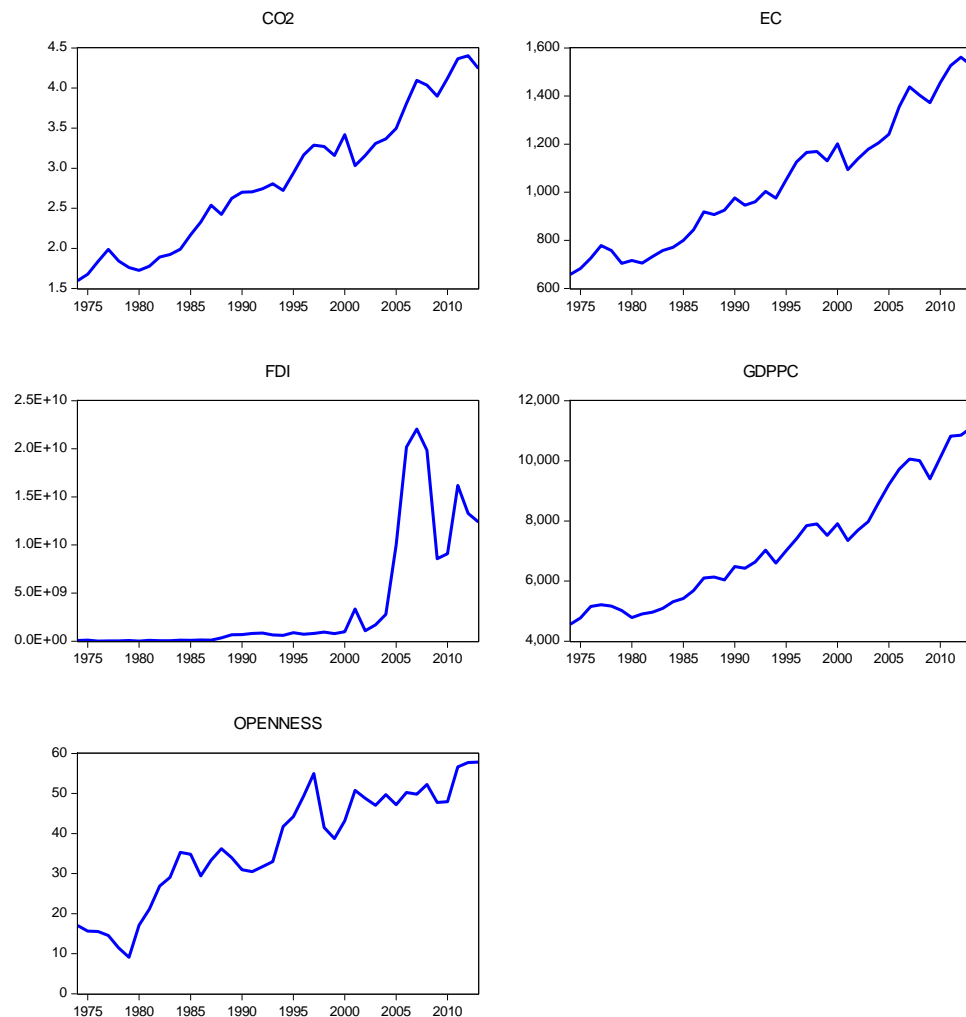

Figure 1. CO_2, EC, FDI, GDPPC and OPENNESS time series of Turkey for the period 1974-2013.

The time series of the variables used in the empirical analysis are presented in Figure 1. All variables (except FDI) have a slight exponential increase. It must be emphasized that considering Turkey's financial liberalization in the late 1980s, a boom in FDI inflow can be seen.

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

$C0_2$: 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. Table 2 presents the correlation matrix for the variables. According to Table 2, EC, FDI, GDPPC and OPENNESS are directly related to CO_2 emissions and significant at 1% level.

Model Specification

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

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

For the purpose of linearity, the model is converted into the natural logarithm in Eq. (2) In this way, the stationarity of the variables is ensured. Furthermore, the coefficients of the model can be used to interpret elasticity.

$$\mathrm{LNCO_2} = \beta_0 + \beta_1 \mathrm{LNEC} + \beta_2 \mathrm{LNFDI} + \beta_3 \mathrm{LNGDPPC} + \beta_4 \mathrm{LNOPENNESS} \qquad (2)$$

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:

$$\text{LNCO}_{2_t} = \beta_0 + \beta_1 \text{LNEC}_t + \beta_2 \text{LNFDI}_t + \beta_3 \text{LNGDPPC}_t + \beta_4 \text{LNGDPPC}^2{}_t + \beta_5 \text{LNOPENNES}_t + \varepsilon_t \ (3)$$

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 or negative. It is obvious that $\beta_1 > 0$ as the reason behind increasing energy consumption is the increase of economic activity which causes pollution. β_3 and β_4 are the coefficients of GDPPC and GDPPC^2. Under the EKC hypothesis the signs are expected to be 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 that FDI contributes to economic growth and environmental degradation accordingly (Xing and Kolstad, 2002; Zhang, 2011; Lau et el, 2014). On the other hand, some economists emphasize that FDI brings environmentally friendly production techniques to the host countries and, as a result, 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 developmental level of the country. As previously stated, Antweiler et al. (2001) and Copeland and Taylor (2004) proposed that trade (or any other determinants of real GDP) impacts environmental quality through three channels: scale (size of economy), composition (specialization) and technique (production methods). For developing countries, the scale effect is dominant. Thus, $\beta_5 > 0$ can be expected. However, considering the dominance of the composition and technological effects, pollution trends will reverse for developed countries, therefore $\beta_5 < 0$.

Bounds Testing Approach for Cointegration

The 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 regardless of whether the variables are I(0) or I(1). Pesaran et al.'s ARDL technique is based on a cointegration analysis, which allows for a building model with variables at different levels. This cointegration analysis is also known as bounds testing.

An ARDL model representation is as follows:

$$\Delta LNCO_{2_t} =$$

$$\alpha_0 + \sum_{i=1}^{n} \alpha_{1i}\Delta LNCO_{2_{t-i}} + \sum_{i=0}^{n} \alpha_{2i}\Delta LNEC_{t-i} + \sum_{i=0}^{n} \alpha_{3i}\Delta LNFDI_{t-i} + \sum_{i=0}^{n} \alpha_{4i}\Delta LNGDPPC_{t-i} +$$

$$\sum_{i=0}^{n} \alpha_{5i}\Delta LNGDPPC^2{}_{t-i} + \sum_{i=0}^{n} \alpha_{6i}\Delta LNOPENNESS_{t-i} + \alpha_7 LNCO_{2_{t-1}} + + \alpha_8 LNFDI_{t-1} +$$

$$\alpha_9 LNGDPPC_{t-1} + \alpha_{10} LNGDPPC^2_{t-1} + \alpha_{11} LNOPENNESS_{t-1} + u_t \qquad (4)$$

where Δ is the difference operator and u_t is white noise error terms. The joint significance of the lagged levels in this equation was 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. Pesaran et al. (2001) computed critical values for I(0) and I(1) for given significance levels with and without a time trend. After establishing a 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: $\Delta LNCO_{2_t} = \gamma_0 +$

$$\sum_{i=1}^{n} \gamma_{1i}\Delta LNCO_{2_{t-i}} + \sum_{i=0}^{n} \gamma_{2i}\Delta LNEC_{t-i} + \sum_{i=0}^{n} \gamma_{3i}\Delta LNFDI_{t-i} + \sum_{i=0}^{n} \gamma_{4i}\Delta LNGDPPC_{t-i} +$$

$$\sum_{i=0}^{n} \gamma_{5i}\Delta LNGDPPC^2{}_{t-i} + \sum_{i=0}^{n} \gamma_{6i}\Delta LNOPENNESS_{t-i} + \lambda ec_{t-1} + v_t \qquad (5)$$

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

EMPIRICAL RESULTS

The results of the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests are presented in Table 3. Both tests demonstrate that all series except FDI are non-stationary at their levels. As can be seen, 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. 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.

Table 4 shows that the computed F-statistics exceed the upper critical bounds values for each model selection criterion. Therefore, according to the 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 used hereafter 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 the unrestricted VAR model. The results are not shown here for the sake of simplicity.

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.

The long run model estimates for the 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 found as 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 the EKC hypothesis in the Turkish economy.

The long run elasticity estimate of CO_2 emissions per capita with respect to FDI is 0.0216 and significant at 10% levels of significance. Considering this regression output, it is acceptable to interpret that FDI has a small impact on CO_2 emissions, as 1% increase in FDI increases CO_2 emissions only by 0.0126%. Finally, the coefficient of OPENNESS is as expected but not significant. Statistics could not be found for the Turkish economy from 1974-2013 to verify this conclusion.

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

Upon checking the regression analysis assumptions, we can conclude that the model is adequate as it passes basic diagnostic tests such as the Jarque-Bera test for normality assumption, the Breusch-Godfrey test for serial correlation, the White test for heteroscedasticity and lastly the Ramsey-Reset test for model specification. Table 6 gives the results of these tests. In addition, Fig. 2 in the appendix for CUSUM and CUSUM squares emphasizes the stability of the coefficients.

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.

$$^a ec_{t-1} = \text{LNCO2} - (1.056\text{LNEC} + 5.999\text{LNGDPPC} - 0.339\text{LNGDPPC}^2 + 0.012\text{LNFDI}$$
$$+ 0.0226\text{LNOPENNESS}$$

In the short run model, the estimated cointegration coefficient (ec_{t-1}) sign is negative, as expected, 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, 77,77% of the discrepancy between the short run and the long run will be closed within the next year.

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 from 1974-2013. For this purpose, it applied the ARDL bounds testing approach to examine the cointegration among the variables. The results 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 the EKC hypothesis in Turkey for the chosen period. Therefore, in Turkey, CO_2 emissions initially increase with GDP per capita, then decline. 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, 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, for the Turkish economy from 1974-2013, statistical proof could not be found to verify this conclusion.

As Halicioglu (2009) indicated, it is obvious that Turkey's energy policy should be reconsidered to reduce 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 environmentally friendly and renewable energy sources. In this sense, decreasing energy intensity or increasing energy efficiency is only possible with alternative policy projections. Importing more green technology and encouraging producers who use green technology with market-based environmental policy instruments may help to solve the problem.

This study can be extended with the sectoral analysis to provide a detailed analysis about the contribution of various sectors to pollution in Turkey. Other variables may also be included in model as potential determinants of CO_2 emissions such as urbanization, exchange rate/terms of trade, population and industrialization for future research.

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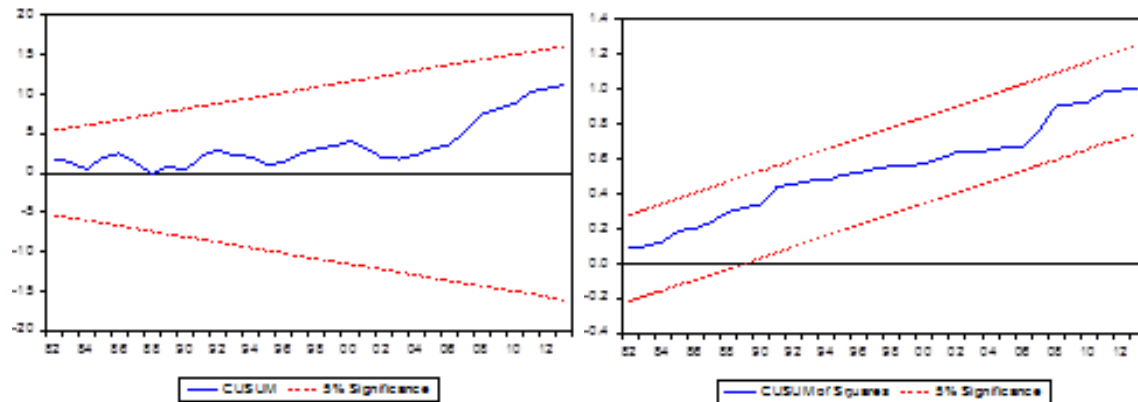
APPENDIX

Fig. 2. Plot of CUSUM and CUSUM of squares tests for the LNCO_2 long-run model.