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The Impact of Economic Growth and Foreign Direct Investment on CO_2 Emissions: The Case of Turkey *

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Abstract. The aim of this study is to evaluate the relationship between carbon dioxide emissions, economic growth, foreign direct investment and energy consumption in Turkey. To this extent, ARDL bounds testing method to cointegration is being implemented over the period of 1970-2014. The long run estimation results suggest that economic growth and energy consumption have positive impacts on CO_2 emissions. However, this research did not find anysignificant relationship between foreign direct investment and CO_2 emissions. As a result of these findings, this research reveals some important policy recommendations.
Keywords. Carbon dioxide emissions, Foreign direct investment, Economic growth, Energy consumption, ARDL.
JEL. F20, O10, Q40, Q50.

1. Introduction

"Sustainable growth" term was firstly used first in Brundtland Report prepared by World Commission on Environment and Development in 1987. This term refers to a sustainable development progress that focuses on the optimum use of today's resources and does not harm to the future generations' resources by tackling environmental issues and development (WCED, 1987). In this context, how the environment is being affected is a serious topic for researchers while countries are developing economically.

The increase in greenhouse gas emissions has led world to face with climate change issue. In this sense, many countries have been searching for a solution to limit greenhouse gas emissions. In 1992, destruction of the ozone layer and climate change issues were discussed at United Nations Environment and Development Conference in Rio. Annex-I countries have admitted taking greenhouse gas emission reductions at the Kyoto Protocol for the period of 2008-2012 in order to limit greenhouse gas emissions (UNFCCC, 1998). However, after IPCC Reports which suggested that developing countries should also take reductions to keep the global warming below 2°C have led to the new discussions. In consequence of this, negotiations in Copenhagen Climate Summit in 2009 were resulted in as failure.

Another turning point for climate change negotiations is the 21st Conference of Parties (COP21) in Paris in 30 November-11 December 2015. 196 countries around the world signed the agreement and a new progress has started with Paris Agreement in terms of tackling climate change. When the context of Paris Agreement is examined it is considered as scientific based, dynamic and a long process agreement. Thus, after Paris Agreement it is proposed that climate-resistant and low-carbon social transformation will take place (Karakaya, 2016).

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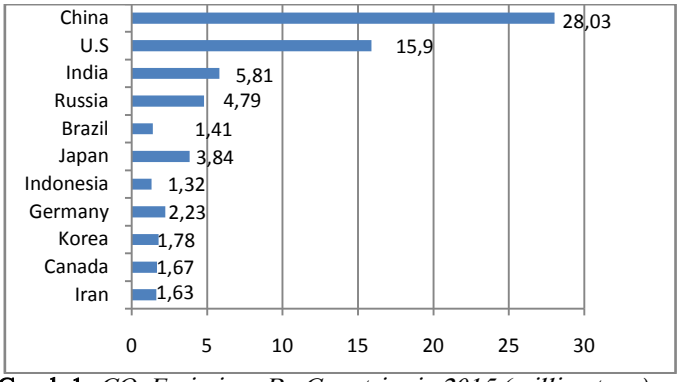
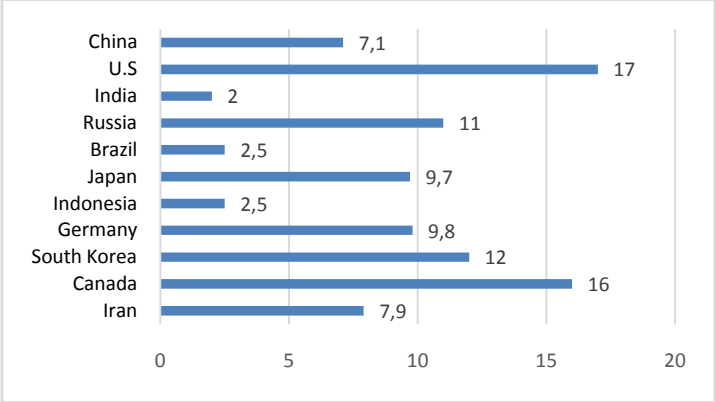
After an international awareness on the issue of climate change, various debates have started on countries' CO_2 emissions and other greenhouse gases. These debates are mostly based on the fact that countries which are responsible for the greenhouse gas emissions according to the historic process should take the reductions. Figure 1 indicates some countries' CO_2 emissions for the year of 2015.



Graph 1. *CO_2 Emissions By Countries in 2015 (million tone)*
Source: The Statistics Portal (2016).

In Figure 1, it is seen that China ranks first in the world with the %28.03 share of CO_2 emissions in 2015. The US follows China with %15.9. India, Russia and Brazil are responsible for CO_2 emissions with the rate share of %5.81, %4.87, 4.17, respectively. On the other hand, according to Global Carbon Atlas (2016), Turkey's share of CO_2 emissions is %1.04 in the world. Another result from Figure 1 is the fact that BRIC countries and the US are responsible for more than half of world CO_2 emissions in 2015. These indicators have revealed that not only developed countries but also developing countries should tackle with climate change and take their place in climate change negotiations.

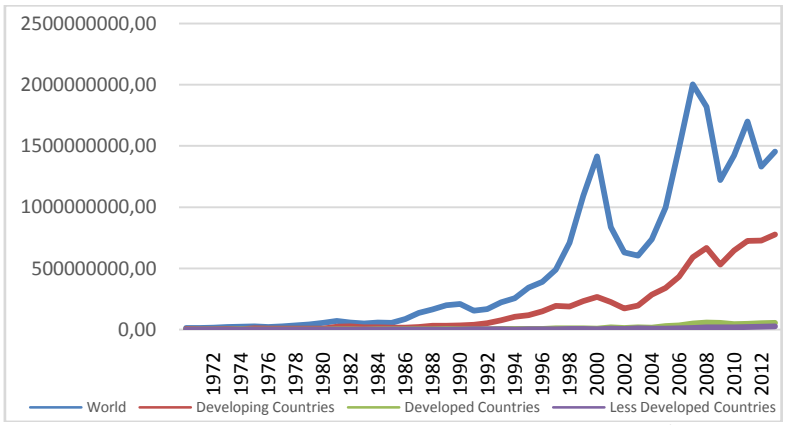


Graph 2. *Per Capita CO_2 Emissions of Highest Emitting Countries (tCO_2)*
Source: Global Carbon Atlas (2016).

In Figure 2, highest CO_2 emitting countries' per capita CO_2 emissions are depicted. According to Figure 2, it is seen that the sequence is different than Figure 1. Accordingly, the countries with the highest per capita CO_2 emissions are the US, Canada, South Korea, Russia and Germany, respectively. In other respects, Global Carbon Atlas (2016) shows that the average per capita CO_2 emissions in the world is 4.19 tCO_2. Turkey's per capita CO_2 emission in 2014 is 4.8 tCO_2. Thus, it is seen that Turkey has shown better performance than many other developed countries in terms of per capita CO_2 emissions.

Nevertheless, financial liberalisation, free capital movements and the emergence of multinational corporations have brought environmental issues. While foreign direct investment affects economic growth positively, it might have some negative

impacts on the environment (Xing & Kolstad, 2002). In this sense, developing countries might ignore the environmental issues for attracting foreign direct investment (Shahbaz *et al.,* 2011).Studies supporting this idea are discussed in the perspective of "Pollution Haven Hypothesis". Figure 3 reveals foreign direct investment position by developed, developing, less developed countries and the world between the period of 1970-2013.



GRAPH 3: *Development of Foreign Direct Investment (Billion $, 1970-2013)*
Source: UNCTAD, (2015).

As it is seen in Figure 3, foreign direct investment which has developed especially since the 1980s has been on the rise in emerging countries since the 1990s.

Contrary to the "Pollution Haven Hypothesis", there is another approach called "Pollution Haven Hypothesis" that argues foreign direct investment reduces environmental pollution in countries. According to this opinion, guest countries that make foreign direct investment have more energy efficiency, high technology and management skills. Thus, FDI contributes to clean environment in developing host countries (Zarsky, 1999). Therefore, FDI leads to decrease greenhouse gas emissions in host countries by rising productivity and energy efficiency and providing management skills.

In the field of environmental pollution in economics, many studies have been conducted under the same roof of "Environmental Kuznets Curve" (EKC). The basis of this approach is based on the study, conducted by Simon Kuznets in 1955, that asserts there is an inverted-U shaped relationship between per capita income and income equality. Kuznets (1955) argues that unfair distribution of income increases in the first process of development, however, it begins to decrease after a certain threshold level. From this point of view, EKC hypothesis claims that the first process of development in the countries leads to environmental pollution, however, after reaching to a certain level of per capita income, the process will become reversed and some improvements in the environment will be observed.

Research questions that motive researcher are as follows: How economic growth and FDI affect CO_2 emissions that cause climate change in Turkey? According to the analysis findings, which policies might be more effective and productive in terms of reducing emissions? This study tries to contribute to the literature by analysing the relationship between economic growth, FDI and CO_2 emissions. Policy recommendations will be discussed according to the analysis results.

This study investigates the relationship between CO_2 emissions, economic growth, FDI and energy consumption over the period of 1970-2014. In this context, second part of the study focuses on the empirical literature and in the third part, model and dataare identified. In the fourth part, method is explained and findings are depicted. Finally, in conclusion, empirical findings are discussed and some policy recommendations are suggested.

2. Empirical Literature

Empirical studies that focus on the relationship between economic growth, FDI and CO_2 emissions generally discuss the validity of EKC, pollution haven and pollution halo hypotheses. In this context, many studies analyze the validity of these hypotheses for different countries/country groups.

Studies related to EKC hypothesis are based on the study that conducted by Grossman & Krueger (1991). In this study, it is determined that there is an inversed-U relationship between determinants of environmental pollution and per capita income by using cross-section method for 42 NAFTA countries. Panayotou (1993) called this finding as EKC hypothesis in his study. Tang & Tan (2015) analyzed the validity of EKC hypothesis for Vietnam by using cointegration analysis over the period of 1976-2009. They found that EKC hypothesis is valid for Vietnam and CO_2 emissions have a bi-directional causality relationship with income and FDI. Kivyiro & Arminen (2014) examined 6 African countries via ARDL bound testing method for 1970-2009 and they found that all variables (CO_2, FDI, energy consumption and economic growth) are moving together in the long term. In addition, EKC hypothesis is valid for Democratic Republic of the Congo, Kenya and Zimbabwe. Pao & Tsai (2011) searched the validity of EKC hypothesis for BRIC countries for 1980-2000 era by using panel data method in BRIC countries. It is found that there is a strong relationship between CO_2 emissions and FDI and there is a uni-directional causality relation from GDP to FDI. Öztürk & Acaravcı (2013) investigated the relationship between financial development, economic growth, trade and CO_2 emissions for the period of 1960-2007 in Turkey. They found that in the long term, a rise in trade increases financial development and CO_2 emissions, however, they stated that those findings are not statistically significant. They also figured out that EKC hypothesis is supported for Turkey in contrast to their previous study in 2010. Halıcıoğlu (2009) examined the relationship between CO_2 emissions, income, energy consumption and foreign trade over the period of 1960-2005 by using ARDL bound testing approach. As a result of the boundary test, two cointegration models were obtained. While first model reveals that CO_2 emissions are determined by energy consumption, income and foreign trade, second model indicates that CO_2 emissions are determined by energy consumption and foreign trade. Finally, it is found that income is the most explanatory variable on CO_2 emissions.

In addition to these findings, Arouri (2012), Annicchiarico *et al.* (2009) and Azomahou (2006) also precipitated similar results and emphasise that EKC hypothesis is supported for the countries that they have included to their analysis for certain periods. However, Arouri (2012), refers to a weak validity of EKC hypothesis in his study. In literature, some studies found that there is no validity of EKC hypothesis as well. Öztürk & Acaravcı (2010) investigated the relationship between CO_2 emissions, economic growth, economic growth, energy consumption and employment rate over the period of 1968-2005 for Turkey by using ARDL method. Analysis results show that while energy consumption increases income, CO_2 emissions decrease it and there is no evidence supporting EKC hypothesis in the study. Finally, Koçak (2014) investigated the validity of EKC hypothesis over the period of 1960-2010 for Turkey by using ARDL bound testing approach and in the study, it is found that EKC hypothesis is not supported for Turkey.

In literature, there are many studies that focus on the validity of Pollution Haven Hypothesis. The globalisation process which was accelerated especially since the 1980 has contributed to the increase of direct foreign investment of the countries. However, while economic growth and capital movements were increasing in the world, it has led to some debates about environmental pollution. Especially developing countries have been ignoring environmental issues to attract FDI in terms of their economic growth. Companies that search for less taxes and regulations have started to invest on developing countries, and therefore, FDI has brought along environmental issues in developing countries. This situation is called

as "Pollution Haven Hypothesis" in the literature. There is not a comprehensive literature on Pollution-Haven Hypothesis for Turkey, however, some studies found the validity of that hypothesis. Şahinöz & Fotourehchi (2014) studied Pollution Haven Hypothesis and Factor Endowment Theory over the period of 1974-2011 for Turkey by using least squares method and they found that only Factor Endowment Theory is supported for Turkey. Gökalp & Yıldırım (2004) stated that demand for dirty industry products are met with importing for the period of 1989-2001 and in this sense, pollutions are transferred to the rest of the world. In addition, they expressed that environmental pollution is not intense in Turkey.

Al-Mulali & Tang (2013) examined the validity of Pollution Haven Hypothesis over the period of 1980-2009 for Gulf Cooperation Council countries by using non-linear panel data method. According to the findings, it is found that FDI is not a source of environmental pollution. Lieter *et al.* (2011) precipitated that environmental regulations increase industry investment by using panel data method for the period of 1998-2007 in European countries.

In literature, it is also possible to find some studies that reject Pollution Haven Hypothesis and accepted Pollution Halo Hypothesis. In contrast to Pollution Haven Hypothesis, Pollution Halo Hypothesis claims that FDI leads to a better environment in developing countries by using high technology, having more productivity and efficiency and management skills. Zeren (2015) tested both Pollution Haven and Pollution Halo Hypotheses in his study for the period of 1970-2010 by using panel FMOLS and CCR cointegration estimators. According to the findings, while Pollution Halo Hypothesis is supported for the U.S, France and England, Pollution Haven Hypothesis is valid for Canada. Akın (2014) examined 12 high-income group countries for 1970-2012 era by using panel data method. Results indicate that there is a negative relationship between FDI and CO_2 emissions. Blanco *et al.* (2013) investigated 18 Latin America countries and found that there is a uni-directional causality relationship from FDI to CO_2 emissions in dirty-intense industries. Thus, FDI has an additive effect on CO_2 emissions. Zhang (2011), examined China for the period of 1980-2009 by using time series method and stresses that FDI has an important role on increasing CO_2 emissions. Yang *et al.* (2008) and Sha & Shi (2006) found similar findings for China by using VAR and panel data methods, respectively. Acharyya (2009) studied India for the period of 1980-2003 and found that FDI is not a sufficient variable to explain Pollution Haven Hypothesis. Merican *et al.* (2007) investigated ASEAN 5 countries for the period of 1970-2007 via ARDL bound testing approach and revealed that FDI increases CO_2 emissions in Malaysia, Philippines and Thailand, however, it has no impact on CO_2 emissions in Indonesia and Singapore. Table 1 presents the summary of the studies in the literature.

Table 1. *Summary of Literature Review*

Author	Country	Period	Method	Findings
Linh & Lin (2015)	Most Populated 12 Asia Countries	1980-2010	Panel Data	CO_2↔ Energy Consumption (short term) Incomer ↔FDI (short term) CO_2→ Energy Consumption, FDI, Income (long term) FDI→ Energy Consumption (long term)
Tang & Tan (2015)	Vietnam	1976-2009	Cointegration and Causality Analysis	CO_2 ↔ Income CO_2↔FDI Energy Consumption ↔ CO_2
Koçak (2014)	Turkey	1960-2010	ARDL	EKC hypothesis is supported.
Kivyiro & Arminen (2014)	6 Africa Countries	1971-2009	ARDL	In the long term, all variables move together. (CO_2, FDI, GDP, Energy Consumption)
Şahinöz & Fotourehchi (2014)	Turkey	1974-2011	OLS	Pollution Haven Hypthesis is supported.
Akın (2014)	12 High-income Countries	1970-2012	Dynamic Panel Data	Negative relationship between FDI and CO_2. Positive relationship between energy consumption and CO_2. Per capita income increases CO_2.

Sbia (2014)	United Arab Emirates	1975-2011	ARDL	FDı and openness increases CO_2. Economic growth increases clean energy consumption.
Azlina *et al.* (2014)	Malaysia	1975-2011	Cointegration and Causality Analysis	CO_2 emisyonları gelir, enerji tüketimi ve yenilenebilir enerji kullanımının Granger nedenidir. CO_2 is granger cause of income, energy consumption and use of renewable energy.
Omri *et al.* (2014)	54 Countries	1990-2011	Dinamik Panel Veri	FDI↔GDP (all countries) CO_2↔FDI (Countries except for North Asia and Europe)
Al-Mulali & Tang (2013)	Gulf Cooperation Council Countries	1980-2009	Non-Linear Panel Data	Pollution Haven Hypthesis is not supported.
Chandran & Tang (2013)	ASEAN-5	1971-2008	Cointegration	While income and road sector energy consumption are the determinants of CO_2 emissions, FDI is not.
Öztürk & Acaravcı (2013)	Turkey	1960-2007	Cointegration	EKC hypothesis is supported.
Mahmood & Chaudary (2012)	Pakistan	1972-2005	ARDL	FDI, value-added manufacturing industry and population intensity increase CO_2.
Al-Mulali (2012)	12 Middle East Countries	1990-2009	Panel Data	GDP ↔ CO_2 FDI ↔ CO_2 EnerjyConsumption ↔ CO_2 Total Trade ↔ CO_2
Farhani & Rejeb (2012)	15 Middle East and North Africa Countries	1973-2008	Panel Data	No relation between GDP, energy consumption and CO_2 in the short term. GDP→Energy Consumption CO_2→ Energy Consumption
Arouri *et al.* (2012)	12 Middle East and North Africa Countries	1981-2005	Panel Data	Energy Consumption increases CO_2.
Sanglimsuwan (2011)	63 Countries	1990, 1995 and 2000	Panel Data	Only in the short term there is a inverted-U shaped relation between CO_2 and GDP.
Wang *et al.* (2011)	28 China States	1995-2007	Panel Data	CO2, GDP and energy consumption are cointegrated. CO_2↔ Energy Consumption Energy Consumption ↔ GDP
Lieter (2011)	EU Countries	1998-2007	Panel Data	Environmental regulations increase investment on industry.
Pao & Tsai (2011)	BRIC Countries	1980-2007	Panel Data	Strong relationship between CO_2 and FDI. GDP→FDI
Choi *et al.* (2010)	China, Japan and Korea	1971-2006	VAR, VEC	"N" shaped EKC for Japan. Inverted-U shaped EKC for Korea. "N" shaped EKC for China.
Öztürk & Acaravcı (2010)	Turkey	1968-2005	ARDL	EKC hypothesis is supported.
Halıcıoğlu (2009)	Turkey	1960-2005	ARDL	Most important factor that determines CO_2 emissions is income which is followed by energy consumption and foreign trade.
Jalil & Mahmud (2009)	China	1975-2005	ARDL	Income and energy consumption are important determinant to increase CO_2 emissions. GDP →CO_2
Annicchiarico *et al.* (2009)	İtaly	1861-2003	Cointegration VEC	CO_2↔ GDP
Azomahou (2006)	100 Countries	1960-1996	Non-Parametric Panel	Positive relationship between economic development ad CO_2 emissions.
Merican *et al.* (2007)	ASEAN 5	1970-2001	ARDL	FDI increases CO_2 emissions in Malaysia, Philippines and Thailand, however it has no impact on CO_2 emissions in Indonesia and Singapore.
Gökalp & Yıldırım (2004)	Turkey	1989-2001	Time Series	Pollution Haven Hypthesis is not supported.
Egli (2004)	Germany	1966-1999	Causality	There is a relationship which similiar with EKC hypothesis between NOx and NH_4.
Koop (1998)	44 Developed and Less Developed Countries	1970-1990	Panel Data	Rich countries make a good progress to decrease CO_2 emissions technically unlike the poor countries.
Grossman & Krueger (1991)	42 NAFTA Countries	1991	Cross-Section	Inverted-U shaped EKC Hypothesis is supported.

3. Model and Empirical Method

Long term econometric model employed for the study as follows:

$$CO_{2t} = \beta_1 + \beta_1 GDP_t + \beta_2 FDI_t + \beta_3 EC_t + e_t \quad (1)$$

In the model, "t", CO_2, FDI, GDP, EC and e_t represent time, per capita CO_2 emissions, per capita FDI, per capita GDP, per capita energy consumption and finally random error term respectively.

In this study, ARDL bound test is preferred. The main reason why this method is chosen is that the method can be employed when stationarity level is below than 1(1) and it is also convenient to use both short and long term analysis at the same time. Narayan (2005) proved statistically that test results obtained via ARDL bound testing approach have less deviations even in micro samples. For ARDL bound testing, short term model of Equation (1) is identified in Equation (2) as follows:

$$\Delta CO_{2t} = \alpha_0 + \sum_{i=1}^{p1} \alpha_{1i} \Delta CO_{2t-i} + \sum_{i=0}^{p2} \alpha_{2i} \Delta GDP_{t-i} + \sum_{i=0}^{p3} \alpha_{3i} \Delta FDI_{t-i} + \sum_{i=0}^{p4} \alpha_{4i} \Delta EC_{t-i} + \\ + \alpha_5 Trend + \alpha_6 CO_{2t-1} + \alpha_7 GDP_{t-1} + \alpha_8 FDI_{t-1} + \alpha_9 EC_{t-1} + \varepsilon_t \quad (2)$$

Unrestricted error correction model of Equation (2) is given in Equation (3) as follows:

$$\Delta CO_{2t} = \alpha_0 + \sum_{i=1}^{p1} \alpha_{1i} \Delta CO_{2t-i} + \sum_{i=0}^{p2} \alpha_{2i} \Delta GDP_{t-i} + \sum_{i=0}^{p3} \alpha_{3i} \Delta FDI_{t-i} + \sum_{i=0}^{p4} \alpha_{4i} \Delta EC_{t-i} + \\ \alpha_6 Trend + \alpha_7 \lambda EC_{t-1} + \mu_t \quad (3)$$

" λEC " is error correction variable in Equation (3). It is expected that coefficient of error correction model is in between -1 and 0. If the coefficient is statistically significant, it means that there is a presence of long-term equilibrium.

Granger & Newbold (1974) expressed that econometric results with non-stationary series have spurious regression. Thus, series which are employed for the analysis should be stationary in econometric analysis to obtain significant relationships between the variables (Tarı, 2002). Granger & Newbold (1974) expressed that econometric results with non-stationary series have spurious regression. Thus, series which are employed for the analysis should be stationary in econometric analysis to obtain significant relationships between the variables (Tarı, 2002). In general, a stochastic process is said to be stationary if its mean and variance are constant over time and the value of the covariance between the two time periods depends only on the distance or gap or lag between the two time periods and not the actual time at which the covariance is computed (Gujarati, 2006). Series which are stationary at level and first difference values are symbolized as I(0) and I(1), respectively.

In the Augmented Dickey-Fuller (ADF) (1981) test, the assumption that errors are independent each other and fixed variance leads to problems when both autoregressive and moving average components are come into question. Philips (1987) and Philips & Perron (1988) developed a unit root test under the assumption that there might be autocorrelation and heteroscedasticity between the error terms. In this study, Phillips-Perron (PP) unit root test is utilized as well as ADF unit root test in order to obtain more reliable results abouth both autocorrelation and heteroscedasticity problems.

4. Method and Findings

In the study, relationship between CO_2 emissions, FDI, GDP and energy consumption is analyzed by using time series data. The study covers the period

1970-2014 with yearly data. Table 2 presents some information about the data employed in the analysis.

Table 2. *Variables Used in Analysis*

Variables	Abbreviation	Explanation	Data Source
Per capita CO_2 emissions	CO_2	Per cdapita metric ton	BP Statistical Yearbook 2015
Per capita GDP	GDP	US Dollar	World Bank
Per capita FDI	FDI	US Dollar	UNCTAD
Per capita energy consumption	EC	Kg (oil equivalent)	World Bank

ADF and PP unit root test results of variables are shown in Table 3.

Table 3. *ADF and PP Unit Root Test Results*

Variables	ADF (Level)	ADF (First Difference)	PP (Level)	PP (First Difference)	Result
CO2	-1.40	-6.46	-1.21	-6.46	I(1)
GDP	3.23	3.32	-2.22	-6.69	I(1)
FDI	-1.59	-6.36	-1.62	-6.35	I(1)
EC	-3.04	-6.52	-3.26	-6.60	I(1)
Critical Value (%1)	-4.18	-3.59			

Note: The value in parentheses for the ADF test indicates the number of lag length according to the SIC criterion. The maximum lag length is 9. At level value, intercept and trend test format and at first difference value, intercept regression equations are used.

Both methods show that while series are not stationary at level values, they are stationary at first difference at 1% significance level except for ADF unit test result of FDI. It can be accepted that all series are I(1). According to the test results, it is appeared that variables have the same cointegration degree.

Since they include both intercept and trend, optimal lag length is supposed to be determined for models specified in Equation 2 and Equation 3. Criteria such as Akaike Information Criterion (AIC), Schwarz Bayesian Criterion (SBC), Hannan-Quin (HQ) are used in order to determine optimal lag length. In the model, the lag length which has the smallest value from these information criteria is used. In addition, model is supposed to have no autocorrelation problem at lag length.

Table 4. *Determination of the Optimal Lag Length*

P	AIC	SBC	B-G Testi
1	6.22	6.54	0.05
2	6.20	6.70	0.02
3	5.86	6.52	0.01

Notes: *, P represents lag length, AIC represents Akaike Information Criterion and SBC represents Schwarz-Bayesian information criterion. **, B- G test expresses probability values of Breusch-Godfrey Autocorrelation test.

Table 4 shows that the maximum lag length for bound testing is 4 and optimal lag length is set to 3 according to AIC ad SBC information criterions in this study and there is no autocorrelation problem at selected lag length.

After determining optimal lag length F statistics are utilized in order to establish a presence of cointegration relationship. In ARDL bound testing, F statistics are adjusted according to lower and upper values appeared in the study conducted by Pesaran *et al.* (2001). However, in this study, critical values created by Narayan (2005) for bound testing are utilized. If the value obtained from the analysis is lower than calculated F-statistics sub-critical values, it is considered that there is no cointegration relationship between the series. However, If it is upper than calculated F-statistics sub-critical values, it is seen that there is a cointegration relationship between the series. Furthermore, it is in the middle of lower and upper values, any information can not be given in terms of cointegration.

Equation (2) is identified as there is no cointegration relationship between the series. In the study, null hypothesis is analyzed by F statistics that tests whether trend and level are not equal to zero as a whole. If there is a cointegration

relationship according to bound testing, ARDL models are defined in order to determine short and long term relationship of variables. Table 5 indicates bound testing results that show the cointegration relationship.

Table 5. *Bound Testing Results*

k*	F Statistics	Lower Bound (%1)	Upper Bound (%1)
3	8.72	4.98	6.42

Note: *k, represents independent variables in the equation. Critical values obtained from Tablo CI(iii) in the study of Narayan (2005).

In Table 5, that since F statistics is above the upper bound, it is seen that there is a presence of cointegration relationship between the variables.

In the study, short and long term coefficients are estimated together and Table 6 shows the findings with diagnostic tests.

Table 6. *ARDL Model Estimation Results*

Short Term			
Variables	Coefficient	Standart Error	T-rasyo (prob.)
CO2(-1)	0.57	0.07	8.36 (0.00)
GDP	0.02	0.004	5.69 (0.00)
FDI	0.01	0.02	0.50 (0.62)
EC	2.97	0.67	4.44 (0.00)
E(-1)	-1.94	0.70	-2.81 (0.01)
Long Term			
GDP	0.05	0.004	11.13 (0.00)
FDI	0.02	0.04	0.50 (0.62)
EC	2.41	0.84	2.86 (0.00)
	Diagnostic Test Results		
R^2	0.99	Normality	2.72^{y}
Heteroscedasticity	0.66^{x}	Autocorrelation	0.70^{x}

Note: ^{x}, and ^{y}, represent Breusch-Godfrey LM test and Jarque- Bera Normality Test, respectively. *, shows significancy at 5% significance level.

Table 6 reveals that long term coefficients of GDP and EC are statistically significant. However, coefficient of FDI is not statistically significant. This case shows that economic growth and energy consumption have a positive impact on CO_2 emissions for the period of 1970-2014 in Turkey. However, it cannot be said that if there is any impact of FDI on CO_2 emissions in Turkey or not.

Diagnostic test results indicate that there are no heteroscedasticity and autocorrelation problems in the model and the error term appears to be normally distributed. These results have importance in terms of reliability of estimation findings of the model.

The results of the error correction model are shown in Table 7.

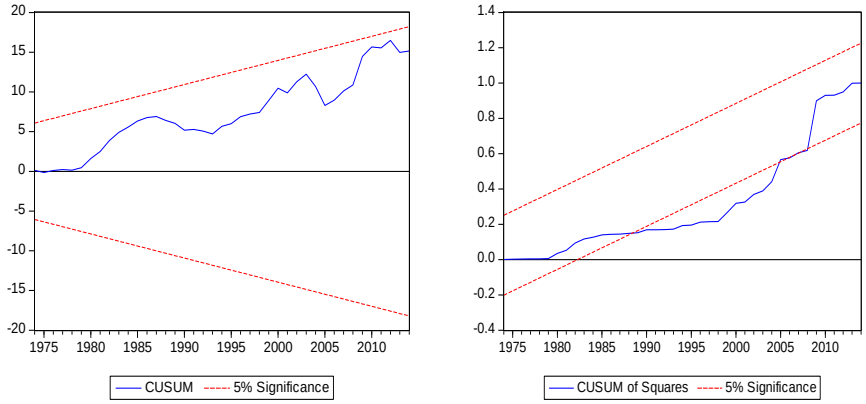
Table 7. *ARDL Error Correction Model Estimation Results*

Variables	Coefficient	Standart Error	T-rasyo(prob.)
Δ GDP	0.03	0.004	6.90 (0.00)
Δ FDI	-0.03	0.02	-1.40 (0.17)
Δ EC	3.09	0.60	5.12(0.00)
EC(-1)	-0.43	0.08	-5.55(0.00)

The results indicated in Table 7 show similarity with long-term coefficients of variables. In this context, it is seen that coefficients of GDP and EC are statistically significant while coefficient of FDI is not. In addition, error correction coefficient is -0.43 which shows that it is significant and negative as expected. This case means that 43% of short-term deviations will be resolved and it will reach long term equilibrium quickly.

Brown *et al.* (1975) developed CUSUM and CUSUMQ stability tests in order to test long term stability of ARDL coefficients. These tests are graphical applications

applied on the error terms represented in Equation (3). According to the test results, if error terms rank among critical values at 5% significance level, it can be considered that estimated model is stable. CUSUM and CUSUMQ results are shown in Figure 4. Accordingly, related values appear in critical values in CUSUM graph. However, although there are some deviations in certain periods, consequently, values return the critical borders. Thus, it can be said that estimated parameters are stable



Graph 4. *CUSUM and CUSUMQ Stability Tests (1970-2014)*

5. Conclusion

This study aims to analyze the relationship among CO_2 emissions, GDP, FDI and energy consumption. For this purpose, ARDL bound testing approach is performed for the period 1970-2014 by using yearly data. Short term error correction coefficient is negative and statistically significant as expected. This case indicates that 40% of short term deviations will be improved in the next period and long term equilibrium will be reached rapidly. According to long-term estimation results, GDP and energy consumption lead to a rise in CO_2 emissions. However, FDI coefficient is not statistically significant. Therefore, there is no exact information whether FDI leads to environmental pollution in Turkey.

According to UNCTAD (2015) statistics, it is seen that the share of FDI in GDP is %1.52 in 2014 in Turkey. Share of FDI in GDP is quite low and it is considered that the reason why there is no definite finding is found whether FDI causes environmental pollution or not is that.

Analysis findings approve that CO_2 emissions are also increasing in Turkey along with economic growth and energy consumption. The reason is that in order to sustain economic growth, major part of energy demand is met by fossil fuels. According to the information in the Ministry of Foreign Affairs of the Republic of Turkey, annual energy demand in 2014 is equivalent to about 125 million tonnes of oil equivalent. According to the projections, it will reach 218 million in 2023. Currently, about 35% of the primary energy demand is covered by natural gas, 28.5% by coal, 27% by oil, 7% by hydro and 2.5% by other renewable sources. In the light of this information, it is seen that 90% of Turkey's energy demand is met by fossil fuels. Turkey should find a solution to decrease greenhouse gas emissions to fight against global climate change issue. However, reducing emissions is required a transformation from fossil fuels based policies into clean energy policies. Turkey should implement a low-carbon energy process by promoting renewable energy and developing productive, efficient, equitable and transparent incentive and licencing mechanisms. In this context, Turkey should obtain optimum benefit by evaluating current renewable resources such as hydro, wind and solar. In addition, nuclear central planned to established in Turkey are considered to decrease energy dependence, create energy variety in energy demand and contribute to limit emissions because of having zero-carbon speciality.

However, it should not be forgotten that security measures are the most indispensable element while discussing nuclear energy.

When these results are evaluated collectively, it is in evidence that Turkey needs to produce and implement more effective and more efficient policies in the context of "sustainable development". These policies should be based not only on macro and micro economic policies but also on realistic, environmental, political and social policies.

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