Turkish Studies **Economics, Finance, Politics**

Volume 14 Issue 2, 2019, p. 307-318

DOI: 10.29228/TurkishStudies.22904

ISSN: 2667-5625

Skopje/MACEDONIA-Ankara/TURKEY

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Research Article / Araştırma Makalesi

Article Info / Makale Bilgisi

✍ *Received/Geliş:* 11.04.2019

✓ *Accepted/Kabul:* 10.06.2019

📅 *Report Dates/Rapor Tarihleri:* Referee 1 (20.05.2019)- Referee 2 (28.05.2019)

This article was checked by iThenticate.

AN EMPIRICAL ANALYSIS OF THE ENVIRONMENTAL KUZNETS CURVE UNDER STRUCTURAL BREAKS: THE EXAMPLE OF TURKEY

*Tuncer GÖVDELI**

ABSTRACT

This paper investigates the presence of the Environmental Kuznets Curve (EKC) in Turkey for the period between 1960 and 2014. Firstly, all variables were identified to be stationary at $I(1)$ level in the study. The Maki (2012) cointegration test that allows structural breaks was used. The elasticity coefficients of the variables and the break years were estimated by FMOLS. The EKC hypothesis suggests that there is an inverted U-shaped relationship between emissions and economic growth. The EKC hypothesis is based on the cointegration relationship between the CO_2 emissions per capita, GDP per capita and the square of GDP per capita. According to the cointegration analysis, there is a long-term relationship between the variables. FMOLS results confirmed the reliability of long-term results. The empirical results indicate an inverted U-shaped relationship between CO_2 emissions and economic growth in Turkey, thus confirming the validity of the EKC hypothesis. The turnaround point was found to be \$3640.95. Energy obtained from fossil fuels is an important factor in environmental pollution. Policy makers need to be more interested in renewable and clean energy sources rather than fossil fuels to be able to meet the energy requirements. The interest of local and foreign investors in this area should be increased. The investments should increase, particularly through the help of incentives to be provided by the government. These incentives include the guarantee for the purchase of energy at a certain value, assignment of space for investors, the creation of technological infrastructures, and so on. Other policy recommendations based on the theoretical and empirical results are provided in the final section of the study.

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STRUCTURED ABSTRACT

Economic growth and development is one of the main objectives of any country. The impact of economic growth on the environment is on the agenda of public policies. Environmental concerns increase as the economy expands. Climate change is a threat to humanity due to global warming. Becoming aware of this threat, governments, institutions and economies take a series of measures. The 1992 Rio Earth Summit and the 1997 Kyoto Agreement drew the attention of the international community with their presentation of negative implications and ways of dealing with them. In the policy arena, the role of developing countries should also be examined. Developed countries decided to reduce their CO₂ emissions by 5% under the Kyoto Agreement, but developing countries did not make any commitments (Galeotti et al., 2006).

This paper intends to contribute to the discussion of environmental degradation by testing the validity of the EKC hypothesis in Turkey through empirical analyses with structural breaks. The difference of this study from others is the empirical analysis of the validity of the EKC hypothesis, with the years of the structural breaks (1964, 1973, 1984 1994, 2008). For this purpose, the variable of trade openness was also used in addition to the variables of energy and economic growth, to be able to test the EKC hypothesis in Turkey for the period between 1960 and 2014. The paper is organized as follows. The second section provides an overview of the literature; the third section explains the data set used in the study and the methodology. In addition, empirical results are interpreted and assessed. The conclusions and political recommendations are provided in the fourth section.

The studies investigating the relationship between CO₂ emissions, energy consumption and economic growth became widespread with increasing environmental pollution. Environmental pollution due to economic growth was empirically tested for developed and developing countries. Shahbaz and Sinha (2019) contributed to the literature by compiling the studies that test the EKC hypothesis. In their study, Grossman and Krueger (1991) examined the impact of the economic growth driven by the North American Free Trade Agreement (NAFTA) on the environment. In this study, which forms the basis of the EKC hypothesis was found. Studies which identified that the inverted U-shaped EKC hypothesis was applicable in Turkey include the following: In a study where Turkey was examined during the period between 1960 and 2013, Ozatac et al. (2017) used the ARDL method and the turnaround point was \$16,648.84. In a study where 11 countries were examined during the period between 1972 and 2013, Shahbaz et al. (2016) found that the inverted U-shaped EKC hypothesis was applicable in Turkey. The turnaround points of the study are \$16,945.73 and \$5,275.43. Ertuğrul et al. (2016) analyzed 10 developing countries for the period between 1971 and 2011. It was found that the inverted U-shaped EKC hypothesis was applicable in Turkey, India, China and Korea and the turnaround point in Turkey was \$6,863.63. In a study where Turkey was examined during the period between 1968 and 2007, Tutulmaz (2015) found the inverted U-shaped EKC hypothesis. Seker et al. (2015) examined Turkey for the period between 1974 and 2010. The turnaround point of the study which found that the inverted U-shaped EKC hypothesis was valid, was \$4,725.39. Bölük and Mert (2015)

analyzed Turkey through ARDL for the period between 1961 and 2010, and found that the inverted U-shaped EKC hypothesis was valid. Shahbaz et al. (2013) analyzed Turkey for the period between 1970 and 2010. The turnaround point of that study was \$4,797.18. Halicioglu (2009) analyzed Turkey through the ARDL method for the period between 1960 and 2005 and the turnaround point was \$1,661.81.

The analyses conducted in the study will be based on a three-stage procedure. First, the stationarity of variables will be analyzed by ADF and Carrion-i-Silvestre et al. (2009) unit root tests. Secondly, the long-term relationships between variables will be identified by using the Maki (2012) cointegration test with structural breaks. Finally, the long-term coefficients of the variables will be estimated by FMOLS.

According to the findings, the EKC hypothesis in Turkey was accepted to be in the form of an inverted U-shape. Trade openness as well as energy consumption leads to environmental degradation in Turkey. Energy obtained from fossil fuels is an important factor in environmental pollution. Policy makers need to be more interested in renewable and clean energy sources rather than fossil fuels to be able to meet the energy requirements. The costs of such energy sources are high. Developing countries may have difficulty in bearing these costs. The interest of local and foreign investors in this area should be increased. The investments should increase, particularly through the help of incentives to be provided by the government. These incentives include the guarantee for the purchase of energy at a certain value, assignment of space for investors, the creation of technological infrastructures, and so on.

One of the key reasons of environmental pollution is CO₂ emissions resulting from energy consumption. To reduce CO₂ emissions, energy consumption needs to be reduced. However, economic growth and development come into play here. One of the key objectives that economists and policy makers have is to prevent such factors that directly affect the development of countries from being adversely affected. The issue of how to reduce CO₂ emissions without reducing the level of economic growth is being thoroughly discussed in recent years. Recovery from environmental pollution is quite difficult and can take many years. The decisions of policy-makers have an impact not only in the present but also for years to come.

Keywords: Environmental Kuznets curve, CO₂ emissions, Economic Growth, Turkey

Jel Codes: O11, O13, Q32

ÇEVRESEL KUZNETS EĞRİSİNİN YAPISAL KIRILMALAR ALTINDA AMPİRİK ANALİZİ: TÜRKİYE ÖRNEĞİ

ÖZ

Bu makale, 1960 ile 2014 dönemi için Türkiye'deki Çevresel Kuznets Eğrisinin (EKC) varlığını araştırmaktadır. Çalışmada öncelikle tüm değişkenlerin I(1) mertebede durağan oldukları tespit edilmiştir. Maki (2012) yapısal kırılmaya izin veren eşbütünleşme testi

kullanılmıştır. FMOLS ile değişkenlerin ve kırılma tarihlerinin esneklik katsayıları tahmin edilmiştir. EKC hipotezi, emisyonlar ile ekonomik büyüme arasında ters U şeklinde bir ilişki olduğunu öne sürmektedir. Kişi başı CO₂ emisyonu, kişi başı GSYİH ve kişi başı GSYİH'nın karesi arasında eşbütünleşme ilişkisi EKC hipotezinin temelini oluşturmaktadır. Eşbütünleşme analizine göre değişkenler arasında uzun dönemli bir ilişki vardır. FMOLS sonuçları uzun dönem sonuçların güvenilirliğini onaylamıştır. Ampirik sonuçlar Türkiye'de CO₂ emisyonu ile ekonomik büyüme arasında ters U şekilli ilişki olduğunu, böylece EKC hipotezinin geçerliliğini doğrulamaktadır. Geri dönüşüm noktasının 3640,95\$ olduğu tespit edilmiştir. Fosil yakıtlardan elde edilen enerji, çevresel kirlenmede önemli bir etkidir. Politika yapıcıların enerjiye olan ihtiyacı karşılayabilmek için, fosil yakıtlar yerine yenilenebilir ve temiz enerji kaynaklarına ilgisini artırmalıdır. Yerel ve yabancı yatırımcıların bu sektöre olan ilgisinin artırılması gerekmektedir. Özellikle devletin uygulayacağı teşvikler ile yatırımlar artacaktır. Bu teşvikler arasında, enerjinin belli bir değerden alım garantisi, yatırımcılara yer tahsili, teknolojik alt yapıların oluşturulması vb. sayılabilir. Teorik ve ampirik sonuçların diğer politika önerileri çalışmanın sonunda önerilmiştir.

Anahtar Kelimeler: Çevresel Kuznets eğrisi, CO₂ emisyonları, Ekonomik Büyüme, Türkiye

Jel Kodları: O11, O13, Q32

1. INTRODUCTION

Economic growth and development is one of the main objectives of any country. The impact of economic growth on the environment is on the agenda of public policies. Environmental concerns increase as the economy expands. Climate change is a threat to humanity due to global warming. Becoming aware of this threat, governments, institutions and economies take a series of measures. The 1992 Rio Earth Summit and the 1997 Kyoto Agreement drew the attention of the international community with their presentation of negative implications and ways of dealing with them. In the policy arena, the role of developing countries should also be examined. Developed countries decided to reduce their CO₂ emissions by 5% under the Kyoto Agreement, but developing countries did not make any commitments (Galeotti et al., 2006).

Some of the significant evidence for climate change, which is the result of CO₂ emissions, include the increasing of global average air temperatures, the warming of the seas and oceans, and the melting of glaciers. According to NASA, global climate change is expected to continue in this century and beyond as well. The rising continuation of the average global temperature affects ecosystems and agriculture. Rising air temperatures, cause natural hazards such as hurricanes to become stronger and more intense. Sea levels have risen by about 20 cm since 1880, when reliable records started to be maintained. The sea levels are expected to rise by 30 to 120 cm until 2100.

Although many factors are listed as the reasons of climate change, the most negative impact on the environment is caused by the increase in energy consumption. Population growth is also an important factor that increases environmental pollution, as it increases energy consumption. The world population grew rapidly in the last 150 years with the increase in average life expectancy, decrease in infant mortality rates and the improvement of farming methods (Martínez-Zarzoso and Maruotti, 2011). The majority of the increase in the world population is experienced in underdeveloped and developing countries.

The Kyoto Protocol requires the parties to either lower CO₂ emissions or to bring its increase under control. Currently, 191 countries and the EU are parties to the protocol. With the Doha Change of the Protocol, the parties are required to reduce emissions by at least 18% until 2020 compared to 1990. In order for this decision to take effect, all 144 countries must approve it. However, the US, Japan, Russia and New Zealand did not make this commitment. The Kyoto Protocol entered into force in 2005 and Turkey became a party to it in 2009, but did not commit to limit or reduce the digitized emissions (Republic of Turkey Ministry of Foreign Affairs, 2019).

Growing at an average rate of 5% in the last decade, the Turkish economy is one of the fastest growing economies in the world. With its cyclical structure, natural resources and developing industries, Turkey attracted the attention of foreign investors, helping its growth and development. The development of Turkey in the last decade is felt not only by economic growth, but also by the increase in energy consumption. Energy consumption which was 1240 kg of oil equivalent per capita in 2005, reached 1577 kg of oil equivalent per capita in 2014.

This paper intends to contribute to the discussion of environmental degradation by testing the validity of the EKC hypothesis in Turkey through empirical analyses with structural breaks. The difference of this study from others is the empirical analysis of the validity of the EKC hypothesis, with the years of the structural breaks (1964, 1973, 1984 1994, 2008). For this purpose, the variable of trade openness was also used in addition to the variables of energy and economic growth, to be able to test the EKC hypothesis in Turkey for the period between 1960 and 2014. The paper is organized as follows. The second section provides an overview of the literature; the third section explains the data set used in the study and the methodology. In addition, empirical results are interpreted and assessed. The conclusions and political recommendations are provided in the fourth section.

2. LITERATURE REVIEW

The studies investigating the relationship between CO₂ emissions, energy consumption and economic growth became widespread with increasing environmental pollution. Environmental pollution due to economic growth was empirically tested for developed and developing countries. Shahbaz and Sinha (2019) contributed to the literature by compiling the studies that test the EKC hypothesis. In their study, Grossman and Krueger (1991) examined the impact of the economic growth driven by the North American Free Trade Agreement (NAFTA) on the environment. In this study, which forms the basis of the EKC hypothesis was found.

Studies in which time series methods are used and the inverted U-shaped EKC hypothesis is valid include the following: Sinha and Shahbaz (2018) used the ARDL method in their study for India during the period between 1971 and 2015. The turnaround point was \$2937.77. In their study, Brazil was examined for the period between 1971 and 2011, and Zambrano-Monserrate et al. (2016) used the ARDL method with a turnaround point of \$2240.06. Sephton and Mann (2016) tested the validity of the EKC hypothesis in the United Kingdom for the period between 1830 and 2003, and the turnaround point was \$9052.67. Balaguer and Cantavella (2016) investigated Spain for the period between 1874 and 2011 through ARDL and the turnaround point was \$8103.08. In a study analyzed India was analyzed for the period between 1971 and 2014 through ARDL, Ahmad et al. (2016) estimated 5 different turnaround points between \$1461.52 and \$863.19. Shahbaz et al. (2015) analyzed 13 African countries for the period between 1980 and 2012. They identified an inverted U-shaped EKC hypothesis in the Republic of Congo, Ethiopia, South Africa and Togo. The turnaround points were \$3213.85, \$851.74, and \$1.045.87 in the Republic of Congo, Ethiopia and Togo, respectively. Baek (2015) examined 7 Arctic countries through ARDL for the period between 1960 and 2010. The test predicted the U-shaped EKC hypothesis in Iceland. Lau et al. (2013) empirically analyzed Malaysia for the period between 1970 and 2008, and the turnaround point was \$11018.40. Kiviyiro and Arminen (2014) examined 6 sub-Saharan countries for the period between 1971 and 2010. They estimated the turnaround points to be \$1080.43,

\$462.18, and \$406.67 in the Republic of the Congo, the Democratic Republic of the Congo and Kenya, respectively. Farhani et al. (2014) investigated Tunisia through ARDL for the period between 1971 and 2008 and the turnaround point was \$4377.35. Cho et al. (2014) analyzed 22 OECD countries for the period between 1971 and 2000. They identified an inverted U-shaped EKC hypothesis in 7 countries. Boutabba (2014) analyzed India for the period between 1971 and 2008. The turnaround point was \$19,370.36. Arouri et al. (2014) analyzed Thailand for the period between 1971 and 2010 through ARDL and found that the inverted U-shaped EKC hypothesis was valid. In the study where Tiwari et al. (2013) examined India for the period between 1966 and 2009, the turnaround point was \$26,517.29. In the study where Sulaiman et al. (2013), examined Malaysia for the period between 1980 and 2009, the inverted U-shaped EKC hypothesis was found to be valid. Shahbaz (2013) analyzed Pakistan through ARDL for the period between 1971 and 2009. The findings indicated that the turnaround point was \$28,523.84. In a study where Kohler (2013) analyzed South Africa for the period between 1960 and 2009 the conclusion was that the inverted U-shaped EKC hypothesis was valid. Kanjilal and Ghosh (2013) analyzed India for the period between 1971 and 2008. In India, the inverted U-shaped EKC hypothesis is valid. Baek and Kim (2013) analyzed Korea for the period between 1975 and 2006 and determined that the inverted U-shaped EKC hypothesis was valid.

Studies which identified that the inverted U-shaped EKC hypothesis was applicable in Turkey include the following: In a study where Turkey was examined during the period between 1960 and 2013, Ozatac et al. (2017) used the ARDL method and the turnaround point was \$16,648.84. In a study where 11 countries were examined during the period between 1972 and 2013, Shahbaz et al. (2016) found that the inverted U-shaped EKC hypothesis was applicable in Turkey. The turnaround points of the study are \$16,945.73 and \$5,275.43. Ertuğrul et al. (2016) analyzed 10 developing countries for the period between 1971 and 2011. It was found that the inverted U-shaped EKC hypothesis was applicable in Turkey, India, China and Korea and the turnaround point in Turkey was \$6,863.63. In a study where Turkey was examined during the period between 1968 and 2007, Tutulmaz (2015) found the inverted U-shaped EKC hypothesis. Seker et al. (2015) examined Turkey for the period between 1974 and 2010. The turnaround point of the study which found that the inverted U-shaped EKC hypothesis was valid, was \$4,725.39. Bölük and Mert (2015) analyzed Turkey through ARDL for the period between 1961 and 2010, and found that the inverted U-shaped EKC hypothesis was valid. Shahbaz et al. (2013) analyzed Turkey for the period between 1970 and 2010. The turnaround point of that study was \$4,797.18. Halicioglu (2009) analyzed Turkey through the ARDL method for the period between 1960 and 2005 and the turnaround point was \$1,661.81.

3. Data, Empirical Strategy And Results

3.1. Data Set

The annual time series for the period between 1960 and 2014 was used in this empirical study. The variables of CO₂ emission (CO₂), economic growth (GDP), economic growth squared (GDP)², energy consumption (E) and trade openness (OP) were used in the study. All variables were taken from the World Development Indicators database of World Bank. CO₂, GDP, and E are measured by metric tons per capita, per capita (current US dollars), and kg of oil equivalent per capita, respectively, while OP is calculated by the following formula: [(Export + Import) / GDP]. The model used in the study:

$$CO2_t = \beta_0 + \beta_1 GDP_t + \beta_2 GDP_t^2 + \beta_3 E_t + \beta_4 OP_t + \varepsilon_t \quad (1)$$

The natural logarithm of all the variables used in Equality 1 is taken and included in the model.

3.2. Empirical Strategy and Results

The analyses conducted in the study will be based on a three-stage procedure. First, the stationarity of variables will be analyzed by ADF and Carrion-i-Silvestre et al. (2009) unit root tests. Secondly, the long-term relationships between variables will be identified by using the Maki (2012)

cointegration test with structural breaks. Finally, the long-term coefficients of the variables will be estimated by FMOLS.

The preliminary and necessary step before the cointegration analysis is the identification of the cointegration relationship in such variables. If the variable is unit rooted, the impact of any crisis or policy change on the variable is permanent. For this reason, the stationarity of the variables should be identified and included in the model.

For long-term variable data, unit root tests that allow structural breaks must be used, in addition to the traditional unit root tests. This study focuses on the period between 1960 and 2014. More than 30 years of data can usually includes endogenous structural breaks. Therefore, the Carrion-i-Silvestre et al. (2009) structural unit root test which allows up to 5 structural breaks was used. Carrion-i-Silvestre et al. (2009) developed the unit root test in which the break date is determined intrinsically, and which allows up to five structural breaks. Five different statistics were used in this test where null hypothesis refers to the presence of a unit root Katircioglu (2014):

$$P_t(\lambda^0) = \frac{[s(\bar{\alpha}, \lambda^0) - \bar{\alpha} s(1, \lambda^0)]}{s^2(\lambda^0)} \quad (2)$$

where P_t refers to the optimum statistics of the Gauss point and S refers to the spectral density function.

$$MP_t(\lambda^0) = \frac{[c^2 T^{-2} \sum_{t=1}^T \tilde{y}_{t-1}^2 + (1-c) T^{-1} \tilde{y}_T^2]}{s(\lambda^0)^2} \quad (3)$$

where MP_t is the point that represents the optimal statistics of the modified applicable point according to Ng and Perron (2001).

$$MZ_\alpha(\lambda^0) = (T^{-1} \tilde{y}_T^2 - s(\lambda^0)^2) (2T^{-2} \sum_{t=1}^T \tilde{y}_{t-1}^2)^{-1} \quad (4)$$

$$MSB(\lambda^0) = (s(\lambda^0)^{-2} T^{-2} \sum_{t=1}^T \tilde{y}_{t-1}^2)^{1/2} \quad (5)$$

$$MZ_t(\lambda^0) = (T^{-1} \tilde{y}_T^2 - s(\lambda^0)^2) (4s(\lambda^0)^2 T^{-2} \sum_{t=1}^T \tilde{y}_{t-1}^2)^{1/2} \quad (6)$$

Table 1: ADF Unit Root Test Results

Variables	Intercept	Trend and Intercept
CO2	-2.8999	-2.5933
Δ CO2	-7.2474 *	-8.1170 *
GDP	-0.0043	-3.1299
Δ GDP	-8.5231 *	-8.3652 *
GDP ²	0.2574	-3.3182
Δ GDP ²	-8.2473 *	-8.1257 *
E	-1.2091	-2.8176
Δ E	-7.1557 *	-7.2439 *
OP	-2.0372	-3.0846
Δ OP	-7.2638 *	-7.1111 *

Note: Schwarz Information Criteria (SIC) was used in lag selection. *, refer to significance levels of 1%.

Table 1 presents the ADF unit root test results at level and first difference. In this test, the null hypothesis that the series is not stationary is accepted for all variables at level, while the null hypothesis is rejected at first difference. Therefore, not all series were found to be stationary at level but were found to be stationary at first difference with a significance level of 1%.

Table 2: Carrion-i-Silvestre et al. Unit Root Test

Variables	TEST STATISTICS					STRUCTURAL BREAKS DATES
	P_t	MP_t	MZ_α	MSB	MZ_t	
CO2	40.96 (5.54)	31.91 (5.54)	-2.42 (-17.32)	0.39 (0.17)	-0.96 (-2.90)	1977, 1983, 1989, 1995, 2004
GDP	10.05 (5.54)	8.28 (5.54)	-11.05 (-17.33)	0.21 (0.17)	-2.34 (-2.90)	1971, 1979, 1993, 2000, 2008
GDP²	12.17 (5.54)	9.94 (5.54)	-9.30 (-17.33)	0.22 (0.17)	-2.12 (-2.90)	1971, 1979, 1993, 2000, 2008
E	12.13 (5.54)	11.32 (5.54)	-8.16 (-17.32)	0.24 (0.17)	-1.96 (-2.90)	1977, 1983, 1990, 2000, 2007
OP	10.96 (5.54)	9.52 (5.54)	-9.97 (-17.32)	0.21 (0.17)	-2.14 (-2.90)	1965, 1971, 1977, 1984, 1997

Note: Critical values are shown in brackets and are produced through 10,000 iterations using bootstrap.

The results of the Carrion-i-Silvestre et al. (2009) unit root test that allows multiple breaks are presented in Table 2. Based on the findings, the null hypothesis that the series has a unit root could not be rejected for all variables at level based on the P_t , MP_t , MZ_α , MSB and MZ_t test statistics. Therefore, all variables were found to have unit roots at level.

Maki (2012) developed a test that allows multiple breaks. The most important feature of this test is the model's endogenous identification of the break dates. Maki (2012) introduced the cointegration test with structural breaks to the literature using four different models. These models are;

Model 0: A trendless model that allows breaks in the fixed term:

$$y_t = \mu + \sum_{i=1}^k \mu_i K_{i,t} + \beta x_t + v_t \quad (7)$$

Model 1: A trendless model that allows breaks in the fixed term and the slope:

$$y_t = \mu + \sum_{i=1}^k \mu_i K_{i,t} + \beta x_t + \sum_{i=1}^k \beta_i x_i K_{i,t} + v_t \quad (8)$$

Model 2: A trended model that allows breaks in the fixed term and the slope:

$$y_t = \mu + \sum_{i=1}^k \mu_i K_{i,t} + \gamma x + \beta x_t + \sum_{i=1}^k \beta_i x_i K_{i,t} + v_t \quad (9)$$

Model 3: The model that allows breaks in the fixed term, slope and trend:

$$y_t = \mu + \sum_{i=1}^k \mu_i K_{i,t} + \gamma x + \sum_{i=1}^k \gamma_i t K_{i,t} + \beta x_t + \sum_{i=1}^k \beta_i x_i K_{i,t} + v_t \quad (10)$$

where; K_i refers to the dummy variables.

Table 3: Results of the Maki (2012) Cointegration Test with Multiple Structural Breaks

	TEST STATISTICS	CRITIC VALUES			STRUCTURAL BREAKS DATES
		1%	5%	10%	
MODEL 0	-7.795*	-6.856	-6.306	-6.039	1963, 1967, 1984, 1994, 2008
MODEL 1	-7.852*	-7.053	-6.494	-6.220	1963, 1967, 1984, 1994, 2008
MODEL 2	-11.186*	-9.441	-8.869	-8.541	1964, 1971, 1984, 1989, 2008
MODEL 3	-11.913*	-10.08	-9.482	-9.151	1965, 1973, 1984, 1990, 2007

Note: *, refer to significance levels of 1%.

According to Equation 1, the cointegration approach was proceeded with. In Table 3, the results of the Maki (2012) cointegration test that allows multiple structural breaks are reported. Based on the results, the null hypothesis in Model 0-1-2-3, which indicates that there is no cointegration, is rejected. Thus, the results of the Maki (2012) cointegration test support the existence of a long-term relationship between CO₂, GDP, GDP², E, and OP.

An analysis of structural breaks in Turkey reveals that the following factors led to breaks in the Turkish economy: the coup attempt in 1963 led by Talat Aydemir; the Cyprus issue and the Vietnam war that broke out in 1964; the first oil crisis that broke out in the world in 1973; liberation of the foreign currency trade transactions, legalization of the value added tax (VAT), and the local elections in 1984; the 1988-1989 crisis; the 1994 crisis, and the reflections of the global crisis of 2008 on the Turkish economy.

Table 4: Results of the FMOLS Estimator

Değişken	Katsayı	Test İstatistiği
<i>Sabit Terim</i>	-10.66772 *	-29.390
<i>GDP</i>	0.328*	3.840
<i>GDP²</i>	-0.02*	-4.905
<i>E</i>	1.518*	25.835
<i>OP</i>	0.041*	2.708
<i>D1964</i>	0.149*	9.546
<i>D1973</i>	-0.074*	-3.879
<i>D1984</i>	-0.03*	-2.350
<i>D1994</i>	-0.076*	-7.187
<i>D2008</i>	-0.038*	-3.009

Note: *, refer to significance levels of 1%.

The empirical results of FMOLS are presented in Table 4. According to the findings, the elasticity coefficient of the variables of GDP, E and OP is positive and statistically significant based on a significance level of 1%. In addition, the GDP² elasticity coefficient is negative and statistically significant based on a significance level of 1%. All the elasticity coefficients of the structural breaks are observed to be statistically significant at a significance level of 1%, and the elasticity coefficient of the 1964 dummy variable is observed to be positive, whereas the elasticity coefficient of the dummy variables of 1973, 1984, 1994 and 2008 is observed to be negative. This may be construed to mean that the shocks in 1973, 1984, 1994 and 2008 affected the country's economy negatively, while the shock of 1964 had a positive impact. In addition, the study estimated the turnaround point to be \$3,640.95¹.

A review of the shocks in the years of the structural breaks in Turkey reveals that Turkey's application for a membership to the European Economic Community (EEC) in 1959 and the entry into force of the Ankara agreement between the EEC and Turkey in 1964 (Özdemir et al., 2016) led to positive developments in Turkey. The first global oil shock in 1973, the significant political events in 1984, the crisis in 1994, and the impact of the global crisis of 2008 can be argued to have led to breaks in Turkey in 2008.

4. Conclusion

The purpose of the study was to identify the validity of the EKC hypothesis in Turkey under structural breaks. For this purpose, the variables of economic growth, energy consumption and trade

¹ $\exp\left(-\frac{\beta_1}{2\beta_1}\right) = 3640,95$

openness were used in addition to the variable of CO₂ emissions. Firstly, all variables were identified to be stationary at I(1) level in the study in which annual data from the period between 1960 and 2014 were used. The long-term relationship between the variables and the structural break years were identified by using the Maki (2012) cointegration test which allows multiple breaks. The elasticity coefficients of the variables and the break years were estimated by FMOLS.

According to the findings, the EKC hypothesis in Turkey was accepted to be in the form of an inverted U-shape. Trade openness as well as energy consumption leads to environmental degradation in Turkey. Energy obtained from fossil fuels is an important factor in environmental pollution. Policy makers need to be more interested in renewable and clean energy sources rather than fossil fuels to be able to meet the energy requirements. The costs of such energy sources are high. Developing countries may have difficulty in bearing these costs. The interest of local and foreign investors in this area should be increased. The investments should increase, particularly through the help of incentives to be provided by the government. These incentives include the guarantee for the purchase of energy at a certain value, assignment of space for investors, the creation of technological infrastructures, and so on.

One of the key reasons of environmental pollution is CO₂ emissions resulting from energy consumption. To reduce CO₂ emissions, energy consumption needs to be reduced. However, economic growth and development come into play here. One of the key objectives that economists and policy makers have is to prevent such factors that directly affect the development of countries from being adversely affected. The issue of how to reduce CO₂ emissions without reducing the level of economic growth is being thoroughly discussed in recent years. Recovery from environmental pollution is quite difficult and can take many years. The decisions of policy-makers have an impact not only in the present but also for years to come.

As countries development levels' increases, sensitivity towards the environment also increases. The findings of this study support this fact in Turkey. As the economic growth in Turkey improves until a GDP per capita of \$3,640.95 is reached, the CO₂ emissions rise, however after the turnaround point, as economic growth increases, environmental pollution declines. In 2002, the GDP per capita in Turkey rose to \$3,660. Therefore, the year 2002 can be considered as the turnaround point in Turkey. Following this year, Turkey has become environmentally more sensitive while growing economically.

Policy makers need to develop policies on forestry, while developing policies to reduce environmental degradation due to economic growth. The damage of the CO₂ emissions on the environment increase as forest areas in Turkey decrease. Forestry, which is a natural solution against environmental pollution, also has a positive effect on economic growth. With a significant impact on both the environment and economic growth, forestry is an issue that needs to be concentrated on more by policy makers.

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