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The Relationship between Coal Consumption, Income Level and CO2 Emissions in Turkey

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ABSTRACT

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As an energy source, coal has had an important place throughout the history of the development of societies. On the other hand, the environmental problems that arise from the fact that the coal is a fossil fuel have made coal-based energy politics controversial. This study examines the relationship between coal consumption, income level and CO2 emissions in Turkey for the period of 1965-2016. The findings of the time series analysis support the Environmental Kuznets Curve (EKC) hypothesis and conservation hypothesis in the long term in Turkey for the mentioned period.

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INTRODUCTION

Coal has always been one of the most important energy sources in the world. Coal, playing a crucial role in the emergence of the industrial revolution in terms of providing the energy needed by the steam machines, has been one of the most preferred energy source, especially in the production of electric energy, due to its cost advantage compared to other energy sources (Jin-ke et al., 2009: 1744). Coal is also used extensively for electrical energy production in Turkey. For instance, the share of electricity produced in coal-fired power plants in total electricity production was 33.9% in 2016 (MENR, 2017).

The importance of various energy sources in electricity generation has been fluctuating by the time but the share of the coal in electricity production has remained a certain level. Therefore, coal always maintains its importance in the production of electricity. For instance, the share of liquid fuels in electricity generation was 30.2% in 1974, 6.7% in 1995 and 0.9% in 2015; while the share of the coal was 32.7%, 32.5% and 29.1% respectively in the same years in Turkey (TURKSTAT, 2017).

Despite the fact that it has a key role in energy production, being a fossil fuel, coal use has been a controversial issue for many years with respect to its harmful effects on environment. Global warming, regarded as the most important environmental problem for all creatures, is considered to be the result of the concentration of greenhouse gases emitted by fossil fuels such as coal used to meet energy needs (Bates et. al., 2008).

The international community has taken a number of measures to combat global warming such as United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol (Bates et. al., 2008). These protocols require countries to fulfill their obligations to overcome climate change and to reduce greenhouse gas emissions. In this context, the use of coal in developed countries has become different from the ones in the developing countries in terms of reduction of the harm to environment. In industrial countries, new methods known as "clean coal technologies" which are sensitive to environment and also produce more energy per unit of coal in coal production and consumption are mostly preferred (TCE, 2016: 21).

The aim of this study is to investigate the relationship between coal consumption, income level and CO₂ emissions in Turkey. In the literature, studies related to this topic are mostly on energy consumption, income level and CO₂ emission relation, and mostly use more general variables related to energy consumption such as energy use or oil use instead of coal consumption. Another difference of this study is that a longer time period is investigated in the empirical analysis. In this study, it is aimed to identify whether the Environmental Kuznets Curve (EKC) is valid and to determine which hypothesis explaining the causal relationship between coal consumption and income level is valid for Turkey over the period of 1965 to 2016.

There are five parts and the first is introduction. The second part discusses the theoretical approaches that explain the relationship between coal consumption, CO₂ emissions and income. In the third, empirical literature is presented. In the fourth part, the relationship between the variables between the years of 1965-2016 in Turkey is investigated by the time series analysis including cointegration test and the causality tests. The study is concluded by empirical findings and general results.

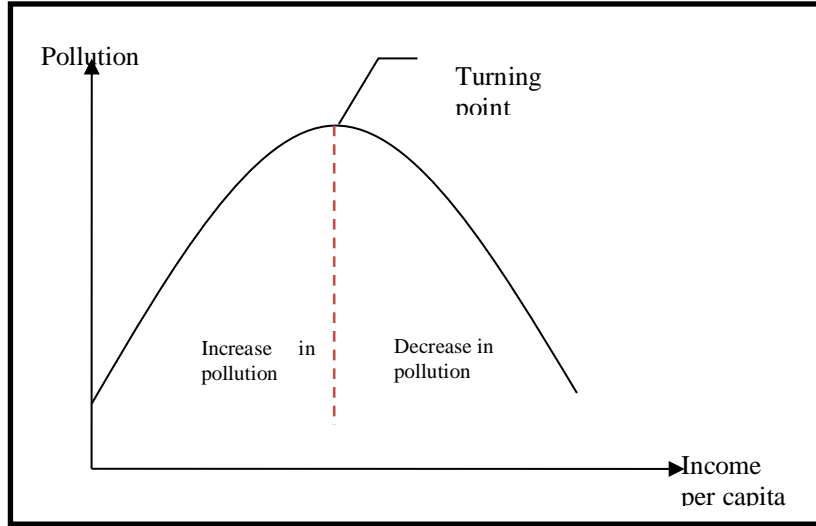
1. Theoretical Framework

The relationship between carbon dioxide emission, coal consumption and income level is explained according to two different theoretical approaches in the literature. First explains the relationship between CO₂ emissions and income level and the second focuses on the relationship between coal consumption and income.

The most popular approach to the relationship between carbon dioxide emissions and income is called the Environmental Kuznets Curve (EKC). Kuznets (1955) has developed a hypothesis that argues that there is an inverse U-shaped relationship between income inequality and economic growth. According to this approach income distribution deteriorates during the initial years of development, and after a certain point it improves by the income.

In the 1990s, Kuznets' approach explaining the relationship between income level and income inequality was rearranged as to show the relationship between income and environmental pollution, and the relationship called as EKC. According to the EKC, CO₂ emissions increase as per capita income increases in the first phase of development. In this period, environmental concerns are disregarded and the amount of pollutant gas emissions is increased in order to increase the production level. However, after a turning point, which corresponds to a certain level of income, the amount of CO₂ emissions begins to decrease by the increase in the income level. According to the EKC, after this certain level of income, nations and the individuals become more conscious about environmental issues and take some measures to fix then environmental quality rises (Atici and Kurt, 2007: 65).

Figure 1: Environmental Kuznets Curve



Source: Song et al., 2008: 382.

According to the EKC shown in Figure 1, in the early years of growth, income per capita rises in the presence of the increase in pollution up to a point, and after this turning point environmental pollution falls following the increase in income level. So the relationship between income level and environmental pollution can be expressed as a second degree function as follows:

$$\text{Environmental Pollution} = a(\text{income}) + b(\text{income})^2 + c \quad (1)$$

According to this function, the turning point, maximizing income level, can be calculated as $a / 2b$ where $a > 0$ and $b < 0$.

The theory of the relationship between coal consumption and income level is developed by hypotheses based on the causalities between energy consumption and income level as explained in Apergis and Payne (2009: 212). Authors have modified the hypothesis based on causality relations between energy consumption and income level as the causalities between coal consumption and income level. In terms of causalities, there occur four different hypotheses between coal consumption and income level (Apergis and Payne, 2010: 1354):

- i. Growth hypothesis
- ii. Conservation hypothesis
- iii. Feedback hypothesis
- iv. Neutrality hypothesis

The growth hypothesis implies that coal consumption is a positive or negative but significant effect on production. According to this approach, changes in coal consumption also affects gross domestic product. As a positive effect, the coal may have a role in the production process, just as labor and capital play; while the negative impact may arise when the industry does not use coal effectively (especially if there is no legal restriction on CO₂ emissions). According to

the growth hypothesis, there is a unilateral causality relation from coal consumption to the income level.

According to the conservation hypothesis, the income level has a significant effect on coal consumption. That an increase in income level increases or decreases the consumption of coal means that the protection hypothesis is valid. Under the conditions that this hypothesis is valid, a reduction in the consumption of coal resulting in energy conservation policies does not lead to any change in the level of income. This hypothesis implies that there is a unilateral causality relation from income level to coal consumption.

The third is the hypothesis that indicates the bilateral causality relationship between the consumption of coal and the income level. According to this hypothesis, the feedback hypothesis, a change in one of these variables causes a change in the other. The mentioned changes can be an increase or a decrease. For example, in an economy in which the coal plays an important role in the production process if a decline in the consumption of coal as a result of energy conservation policies decreases the income level, and this leads to a reduction in the consumption of coal, the feedback hypothesis is valid.

The last hypothesis is the neutrality hypothesis, and in this case there is not any causal relationship between coal consumption and income level. According to the hypothesis, two variables move independently of each other, and the increase or decrease in one of the variables does not cause any change in the other variable.

2. Literature Review

Empirical studies on EKC have become popular following Grossman and Krueger's (1991) study on the relationship between air pollution and growth. New studies on EKC have developed the analysis by adding energy consumption variables to the model. On the other hand some researchers have included variables such as financial development, trade openness, and foreign direct investment to the analysis as control. Pao and Tsai (2011) have tested EKC for the BRICs and their results have supported EKC for the period of 1980 and 2007. Saboori et al. (2012) have found that there is an inverse U-shape relationship between carbon dioxide emissions and income level in Malaysia for the period of 1980-2009. EKC have tested for Turkey in many studies. Akbostancı et al. (2009) have tested EKC for the period of 1968 and 2003 and they have reached the findings that the EKC is N-shaped in Turkey. Yurttagüler and Kutlu (2017) have tested the EKC for the period of 1960-2011, and they have found that the relationship between the variables is N-shaped. Özataç et al. (2017) have also found results supporting the EKC hypothesis for the period from 1960 to 2013. However, Bozdağhoğlu and Çakır (2013) have reached the results that argue EKC is not valid for Turkey between the years of 1960 and 2011.

Although there are many studies investigating the relationship between energy consumption and income level, in the literature there is less study focusing on coal instead of energy consumption. In Turkey case, Öcal et al. (2013) have investigated the relationship between coal consumption and GDP and their findings support that the neutrality hypothesis is valid between the years of 1980 and 2006. Bildirici and Bakırtaş (2014) have examined the theory for BRICTS countries, including Turkey, and they have found that there is no causality relation between coal consumption and growth for Turkey in the period of 1980-2011. In the other studies, Yang (2000) has found that protection hypothesis is valid in the period of 1954-1997 in Taiwan. In Li and Leung (2012) there is a bilateral causality relationship between coal consumption and income level between the years of 1985 and 2008 for China. Govindaraju and Tang (2013) have found that the feedback hypothesis is valid in China between 1965 and 2009. Authors have reached findings in accordance with the growth hypothesis for India case.

3. Empirical Analysis

3.1. Data

In the analysis, we have used the variables CO₂ emissions, per capita income and coal consumption in Turkey for the period of 1965-2016 in logarithmic form. CO₂ emissions and coal consumption series have been obtained from the BP Statistical Review of World Energy

2017. Income per capita series has been obtained from the World Bank database in current US dollars.

Figure 2: Time Series Graphs

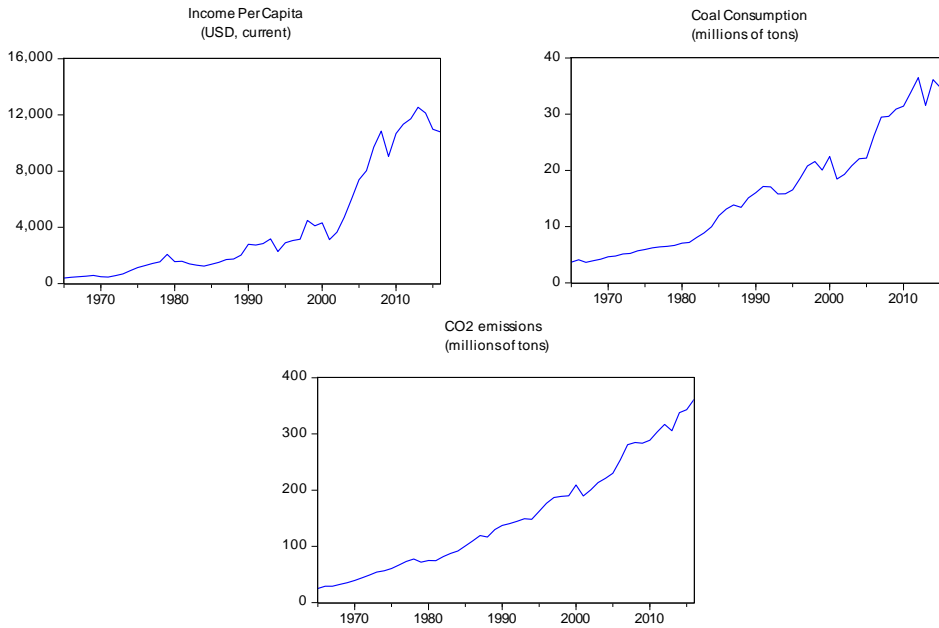


Figure 2 shows the graphs of time series. As can be seen in the figure, per capita income fluctuates over time with a positive trend. The impacts of the local and global crises occurred in 2001 and 2008 are shown as declines in mentioned years. In the coal consumption series, there is a clear positive trend although partial volatility begins after the second half of the 1980s. The CO₂ emissions series, which is a relatively stable, increases at a certain rate over time.

3.2. Methodology

In the analysis following the Johansen cointegration approach, first we have investigated the stationarity of the series then tested whether the series are cointegrated. Long term error correction mechanism and causalities have been investigated by the vector error correction model (VECM). Stationarity level of the series have been determined using ADF test. In the ADF test, using models with or without trend and constant components, the null hypothesis is that series has a unit root, and the alternative hypothesis is that series is stationary (Çil Yavuz, 2004: 241). ADF test applied can be formulated as equations below:

$$\Delta Y_t = \alpha + \phi Y_{t-1} + \sum_{i=1}^k \delta_i \Delta Y_{t-i} + u_t \quad (2a)$$

$$\Delta Y_t = \alpha + \beta T + \phi Y_{t-1} + \sum_{i=1}^k \delta_i \Delta Y_{t-i} + u_t \quad (2b)$$

$$\Delta Y_t = \phi Y_{t-1} + \sum_{i=1}^k \delta_i \Delta Y_{t-i} + u_t \quad (2c)$$

In the equations, testing the stationarity of Y_t , α is constant, and T is the deterministic trend. k which is the lag of the dependent variable is used to avoid serial correlation. So, the stationary of series is determined by the significance of ϕ . Thus, when $H_0: \phi = 0$ and $H_1: \phi < 0$, rejection of the H_0 means that the series is stationary.

Working with the series which are not stationary at level, a common way to test long term relationship between the variables is cointegration analysis, which assumes that linear combinations of nonstationary time series are stationary at a certain level of integration (Bozkurt, 2007: 162).

The cointegration test proposed by Johansen (1988) and Johansen and Juselius (1990) is defined in terms of vector autoregression (VAR) as follows:

$$\Delta X_t = \Gamma \Delta X_{t-1} + \dots + \Gamma_{k-1} \Delta X_{t-k} + \Pi \Delta X_{t-k} + \varepsilon_t \quad (3)$$

$$\Gamma_i = -I + \Pi_1 + \Pi_i, i = 1 \dots k$$

In the model, Π denotes the matrix of coefficients with a rank (Γ) which is the number of cointegrated vectors that between the series. If the rank of the matrix is equal to zero, then the series are not cointegrated, but if the rank is non-zero then the series are cointegrated. In the Johansen test, cointegration relation between the series is determined by the trace and maximum eigenvalue statistics. In the trace test, the null hypothesis which indicates the presence of less than or equal to Γ cointegrated vectors is tested. Maximum eigenvalue tests the alternative hypothesis, $\Gamma + 1$ cointegrated vectors, against the null hypothesis that there is Γ number of cointegrated vectors

3.3. Results

Findings of stationarity analysis are summarized in Table 1.

Table 1: ADF Unit Root Test Results

Model	Level				
		lnCO ₂	lnCOAL	lnGDP	(lnGDP) ²
Constant	t-Statistic	-2.8530	-0.8739	-1.0774	-0.7361
	Prob.	0.0581	0.7886	0.7179	0.8281
Constant and trend	t-Statistic	-2.5851	-2.0452	-2.5511	-2.4922
	Prob.	0.2885	0.5630	0.3036	0.3306
None	t-Statistic	6.5797	3.8939	2.8004	2.5882
	Prob.	1.0000	0.9999	0.9985	0.9973
Model	First Difference				
		Δ lnCO ₂	Δ lnCOAL	Δ lnGDP	Δ (lnGDP) ²
Constant	t-Statistic	-7.3576 *	-8.1688 *	-6.9531 *	-7.1312 *
	Prob.	0.0000	0.0000	0.0000	0.0000
Constant and trend	t-Statistic	-7.9758 *	-8.1070 *	-6.9106 *	-7.0595 *
	Prob.	0.0000	0.0000	0.0000	0.0000
None	t-Statistic	-2.1317 *	-2.9031 *	-6.0884 *	-6.2502 *
	Prob.	0.0330	0.0045	0.0000	0.0000

Note: Lag lengths are based on the Schwarz information criteria. * represents that the series is stationary at level of significance of 5%.

According to the ADF test, log values of CO₂ emissions, coal consumption, per capita income and per capita income level have unit roots at 5% level of significance. Stationarity is ensured by taking the differences of the series. According to the results of the ADF unit root test, all series are stationary at the first difference, so they can be included in the Johansen cointegration test for the determination of the long term relationship.

Table 2: Johansen Cointegration Test Results

H ₀ : rank=r	Trace Stat.	Critical value (%5)	Prob.	Max. Eigenvalue Stat.	Critical value (%5)	Prob.
r = 0	65.56565 *	54.07904	0.0034	36.32824 *	28.58808	0.0042
r ≤ 1	29.23741	35.19275	0.1903	17.0632	22.29962	0.2293
r ≤ 2	12.17421	20.26184	0.4333	9.066887	15.8921	0.4267
r ≤ 3	3.107326	9.164546	0.5609	3.107326	9.164546	0.5609

Note: * Shows that the null hypothesis H₀ rejected at the 5% significance level. Lag length selected in the VAR is 1 and determined via Schwarz Information Criteria (SIC).

Table 2 summarizes the findings of Johansen Cointegration test. The null hypothesis, denoted by r = 0 which means there is no cointegration relation between variables, is rejected at the 5%

level of significance according to both trace and maximum eigenvalue statistics. So the findings reveal the existence of one cointegration relationship between the series.

Table 3: Normalized Cointegrating Vector Coefficients

lnCO ₂	lnCOAL	lnGDP	(lnGDP) ²	C
1.000000	-0.43113 (0.13344)	-2.48794 (0.48512)	0.125157 (0.02812)	8.248324 (1.92547)
	[-3.23090] *	[-5.12846] *	[4.45076] *	[4.28381] *

Note: The numbers in parentheses are the standard deviation, and the numbers in brackets indicate the t-statistic value. * indicates significance at 5% level.

The results of normalized the cointegrating vector in terms of lnCO₂ can be shown at Table 3. As seen in the table, all the variables are significant at 5% level of significance.

Transforming the vector into an equation one can reach the equation below:

$$lnCO_2 = -8.2483 + 0.4311 lnCOAL + 2.4879 lnGDP - 0.1251 (lnGDP)^2$$

According to the equation, in which the coefficient of income is positive and the coefficient of income-square is negative, there is an inverse U-shaped relation between income and CO₂ emissions in the period 1965-2016, in accordance with the EKC approach. We have calculated the turning point using equation (1), and it is found 20,720 current US dollars and this value is beyond the analysis period. Cointegrated vector findings show that coal consumption has a positive effect on the CO₂ emissions as expected.

After determining the existence of cointegration among series, we have investigated the error correction mechanism and causalities in both short and long term by the vector error correction model (VECM). Using VECM, error correction mechanism and short-term causalities have tested by the following equations:

$$\Delta lnCO_2 = \alpha_0 + \alpha_1 \Delta lnCO_{2,t-1} + \alpha_2 \Delta lnCOAL_{t-1} + \alpha_3 \Delta lnGDP_{t-1} + \alpha_4 \Delta (lnGDP)^2_{t-1} + \gamma_1 EC_{1,t-1} + \varepsilon_t \quad (4a)$$

$$\Delta lnCOAL = \beta_0 + \beta_1 \Delta lnCOAL_{t-1} + \beta_2 \Delta lnCO_{2,t-1} + \beta_3 \Delta lnGDP_{t-1} + \beta_4 \Delta (lnGDP)^2_{t-1} + \gamma_2 EC_{2,t-1} + u_t \quad (4b)$$

$$\Delta lnGDP = \theta_0 + \theta_1 \Delta lnGDP_{t-1} + \theta_2 \Delta lnCO_{2,t-1} + \theta_3 \Delta lnCOAL_{t-1} + \theta_4 \Delta (lnGDP)^2_{t-1} + \gamma_3 EC_{3,t-1} + v_t \quad (4c)$$

In the models, *EC* is error correction term and represents the lagged value of the error terms obtained from the linear combinations of the differenced series. The significance and sign of the coefficient of the *EC* indicate whether the error correction mechanism is working. So, if γ is significant then the error correction mechanism works among the series and if the sign of coefficient is negative (positive) that means series converge (diverge) to (from) their long term equilibrium due to short term movements. Findings of the error correction model are summarized in Table 4.

Table 4: Vector Error Correction Model (VECM) Findings and Short Term Causality Relations

	$\Delta lnCO_2$	$\Delta lnCOAL$	$\Delta lnGDP$
EC (-1)	0.2282 (6.1195)* [0.0000]		
$\Delta lnCO_2$ (-1)	-0.4137 (-1.7193) [0.0924]	-0.6845 (-1.7334) [0.0899]	-0.1909 (-0.2320) [0.8175]
$\Delta lnCOAL$ (-1)	0.0751	0.1223	0.2199

	(0.5545) [0.5820]	(0.5503) [0.5848]	(0.4749) [0.6371]
$\Delta \ln GDP (-1)$	-0.4056 (-1.0655) [0.2923]	-0.9208 (-1.4742) [0.1474]	0.9723 (0.7469) [0.4590]
$\Delta(\ln GDP)^2 (-1)$	0.0290 (1.1942) [0.2386]	0.0632 (1.5818) [0.1207]	-0.0611 (-0.7336) [0.4669]

Notes: * indicates significance at 5% level. The lag length is 1 according to the Schwarz information criterion. Numbers in parentheses indicate t stats, numbers in square brackets indicate p-probability values.

According to the error correction model in which carbon dioxide emission is dependent variable, the coefficient of the error correction term is found to be significant but positive in the 5% level of significance. So it is found that the short-term changes in the series cause divergences from the equilibrium in the long run and imbalance between the series increases by 22 percent per period.

Short-term causalities have been determined by the significance of the coefficients of the lagged independent variables via equation (4). So it can be seen on the VECM results, there are no short run causalities between CO₂ emissions, per capita income and coal consumption at the significance level of 0.05. The long term causalities between the series have been determined by using Wald test for joint significance of each of the independent variables with the coefficient of the error correction term in the VECM.

The Wald test results of long-term causalities are shown in Table 5.

Table 5: Wald Test Results Showing Long Term Causality Relation

Null Hypothesis	F-stats	Prob.
$\gamma_1 = \alpha_2 = 0$	20.52080 *	0.0000
$\gamma_1 = \alpha_3 = 0$	18.87426 *	0.0000
$\gamma_2 = \beta_2 = 0$	9.941310 *	0.0003
$\gamma_2 = \beta_3 = 0$	8.026710 *	0.0010
$\gamma_3 = \theta_2 = 0$	3.349957 *	0.0440
$\gamma_3 = \theta_3 = 0$	1.732555	0.1884

Note: * denotes significance at 5% level.

In Wald test, we have found that there are bilateral causality relationships between carbon dioxide emissions and per capita income, and between coal consumption and carbon dioxide emissions. Test findings also reveal that there is a unilateral long-term causality from income to coal consumption at the level of 5% significance.

Table 6: Causalities in the Short and Long Term

Short Term		
CO ₂ Emissions	X	Income per Capita
Coal Consumption	X	CO ₂ Emissions
Income per Capita	X	Coal Consumption
Long Term		
CO ₂ Emissions	↔	Income Per Capita
Coal Consumption	↔	CO ₂ Emissions
Income Per Capita	→	Coal Consumption

The short and long run causality relationships obtained from the analysis are summarized in Table 6. According to these results, there is no causality relation among the variables in the short term.

The unilateral causality relationship from income per capita to coal consumption in the long run reveals that the protection hypothesis is valid for Turkey. Thus, in Turkey, coal consumption is determined by economic growth for the analysis period. The unilateral causality from income to coal consumption allows for the implementation of a conservative energy policies in order to reduce coal consumption which will not have an impact on income. On the other hand, according to protection hypothesis, an increase in per capita income could lead to decrease in coal consumption and so decrease in environmental pollution (Apergis and Payne, 2010: 1354).

4. Conclusion and Policy Implications

In this study, the relationship between CO₂ emissions, income level and coal consumption in Turkey between the years of 1965-2016 is examined. In this context, it is empirically investigated whether the EKC is valid in Turkey or not and is determined which hypotheses explaining the causal relationship between coal consumption and income level is prevailing.

Test results show that the carbon dioxide emission, income level and coal consumption are cointegrated and the cointegrated vector findings reveal the inverse U-shaped relationship between income level and CO₂ emission. Therefore our analysis shows that EKC is valid in Turkey. We have calculated the turning point of income level for Turkey is about 20,000 dollars which is beyond our analysis period.

VECM results show that the short run changes in variables have divergent effects in the long run. The short and long term causality tests applied using VECM reveal that neutrality hypothesis is valid in the short term but protection hypothesis is valid in the long run for Turkey. So, long term conservative energy policies do not affect the per capita income level in Turkey; however any change in the level of income does not have a significant impact on coal consumption.

Findings of the analysis argue that the turning point of the EKC has not yet been reached yet. Therefore, the increase in per capita income will increase the environmental pollution until reaching the turning point. For this reason, the policies to be implemented should ensure that environmental concerns in the society are more prominent than economic concerns and this can only be achieved by reaching a certain level of income for the individuals who constitute the society. On the other hand, the validity of conservation hypothesis can be interpreted as the use of non-coal energy sources does not have any negative impact on the level of income in Turkey. Therefore, sustainable growth can be achieved through using cleaner energy sources.

REFERENCES

- Akbostancı, E., Türüt-Aşık, S. ve Tunç, G. İ. (2009), "The Relationship between Income and Environment in Turkey: Is There an Environmental Kuznets Curve?", *Energy Policy*, 37, s.861-867.
- Apergis, N. ve Payne, J. E. (2009), "Energy Consumption and Economic Growth in Central America: Evidence from a Panel Cointegration and Error Correction Model", *Energy Economics*, 31, p.211-216.
- Apergis, N. ve Payne, J. E. (2010), "Coal Consumption and Economic Growth: Evidence from a Panel of OECD Countries", *Energy Policy*, 38, p.1353-1359.
- Atıcı, C. ve Kurt, F. (2007), "Türkiye'nin Dış Ticareti ve Çevre Kirliliği: Çevresel Kuznets Eğrisi Yaklaşımı", *Tarım Ekonomisi Dergisi*, 13(2), s.61-69.
- Bates, B. C., Kundzewicz, Z. W., Wu, S. and Palutikof, J. P. (2008), "Climate Change and Water" Technical Paper of the Intergovernment Panel on Climate Change, IPPC Secretariat, Geneva.
- Bildirici, M. E. ve Bakırtaş, T. (2014), "The Relationship among Oil, Natural Gas and Coal Consumption and Economic Growth in BRICTS (Brazil, Russian, India, China, Turkey and South Africa) Countries", *Energy*, 65, p.134-144.

- Bozdağlıoğlu, E. Y. ve Çakır, M. (2013), "Economic Growth and Environmental Quality in Turkey: Are They Opposite Concepts?", *International Journal of Economics and Finance Studies*, 5(1), p.85-95.
- Bozkurt, H. (2007), *Zaman Serileri Analizi*. Bursa, Ekin Kitabevi.
- BP (British Petroleum), (2017), Statistical Review of World Energy 2017. Available at: <https://www.bp.com/content/dam/bp/en/corporate/excel/energy-economics/statistical-review-2017/bp-statistical-review-of-world-energy-2017-underpinning-data.xlsx>, 23.11.2017.
- Çil Yavuz, N. (2014), "Durağanlığın Belirlenmesinde KPSS ve ADF Testleri", *İktisat Fakültesi Mecmuası*, 54, p.239-247.
- Govindaraju, V. G. R. C. ve Tang, C. F. (2013), "The Dynamic Links between CO2 Emissions, Economic Growth and Coal Consumption in China and India", *Applied Energy*, 104, p.310-318.
- Grossman, G. M. ve Krueger, A. B. (1991), "Environmental Impacts of a North American Free Trade Agreement", NBER Working Paper No: 3914.
- Jin-ke, L., Feng-hua, W. ve Hua-ling, S. (2009), "Differences in Coal Consumption Patterns and Economic Growth between Developed and Developing Countries", *Procedia Earth and Planetary Science*, 1, p.1744-1750.
- Johansen, S. ve Juselius, K. (1990), "Maximum Likelihood Estimation Vectors in Gaussian Vector Autoregressive Models", *Econometrica*, 55, p.1151-1180.
- Johansen, S. (1988), "Statistical Analysis of Cointegrating Vectors", *Journal of Economic Dynamics and Control*, 12, p.231-254.
- Kuznets, S. (1955), "Economic Growth and Income Inequality", *The American Economic Review*, 45(1), p.1-28.
- Li, R. ve Leung, G. C. K. (2012), "Coal Consumption and Economic Growth in China", *Energy Policy*, 40, p.438-443.
- Öcal, O., Öztürk, İ. ve Aslan, A. (2013), "Coal Consumption and Economic Growth in Turkey" *International Journal of Energy Economics and Policy*, 3(2), p.193-198.
- Özataç, N., Gökmenoğlu, K. K. ve Taşpınar, N. (2017), "Testing the EKC Hypothesis by Considering Trade Openness, Urbanization, and Financial Development: The Case of Turkey" *Environmental Science and Pollution Research*, 24, p.16690-16701.
- Pao, H. ve Tsai, C. (2011), "Multivariate Granger Causality between CO2 Emissions, Energy Consumption, FDI (Foreign Direct Investment) and GDP (Gross Domestic Product): Evidence from a Panel of BRIC (Brazil, Russian Federation, India, and China) Countries", *Energy*, 36(1), p.685-693.
- MENR (Republic of Turkey Ministry of Energy and Natural Resources), (2017), "Kömür" <http://www.enerji.gov.tr/tr-TR/Sayfalar/Komur>, 05.09.2017.
- Saboori, B., Sulaiman, J., ve Mohd, S. (2012), "Economic Growth and CO2 Emissions in Malaysia: A Cointegration Analysis of the Environmental Kuznets Curve", *Energy Policy* 51, p.184-191.
- Song, T., Zheng, T., ve Tong, L. (2008), "An Empirical Test of the Environmental Kuznets Curve in China: A Panel Cointegration Approach", *China Economic Review*, 19, p.381-392.
- TCE (Turkish Coal Enterprises), (2016), "Coal Sector Report" <http://www.enerji.gov.tr/File/?path=ROOT%2F1%2FDocuments%2FSEKT%C3%B6r%20Raporu%2FSEKT%C3%96R%20RAPORU%202015%2030.06.2015%20SON.pdf>, 04.09.2017.

- TURKSTAT (Türkiye İstatistik Kurumu), (2017), “Enerji İstatistikleri”
http://www.tuik.gov.tr/PreTablo.do?alt_id=1029, 02.08.2017.
- Worldbank (2017), <http://databank.worldbank.org/>, 25.11.2017
- Yang, H. (2000), “Coal Consumption and Economic Growth in Taiwan”, *Energy Sources*, 22(2), p.109-115.
- Yurttagüler, İ. M. ve Kutlu, S. (2017), “An Econometric Analysis of the Environmental Kuznets Curve: The Case of Turkey”, *The Journal of Operations Research, Statistics, Econometrics and Management Information Systems*, 5(1), p.116-126.