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Testing the Environmental Kuznets Curve Hypothesis: An Empirical Study for Türkiye

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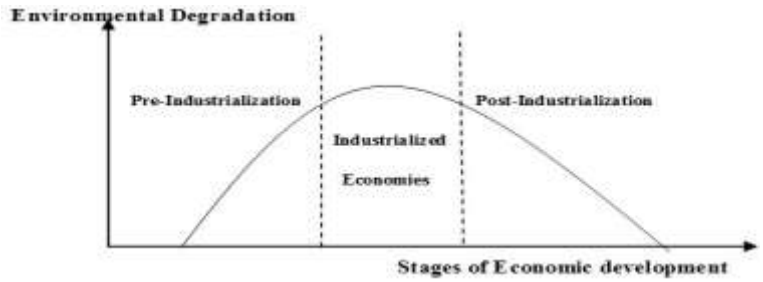
Abstract

This study aims to examine the causality relationship between environmental pollution, economic growth and energy consumption in Türkiye within the scope of the Environmental Kuznets Curve (EKC) hypothesis. The validity of the EKC hypothesis was analyzed via a quadratic form using the 1960-2015 time period data for Türkiye. The analysis consists of two stages. In the first phase, the stationarity of the series was tested with ADF and PP unit root tests. In the second phase, the existence of a causal relationship between the parameters was examined by the Granger Causality test. According to the empirical findings, there was no causality relationship between the variables of carbon dioxide emission, energy consumption and economic growth. It has been concluded that the EKC hypothesis, there was an inverse-U-shaped relationship between economic growth and environmental degradation, was not valid for the Turkish economy. In this case, governments need to take additional measures, as the negative effects on the environment will not decrease by themselves as income increases. Developing countries such as Türkiye should reshape the energy matrix in favor of renewable energy through technological transfer.

Keywords: Environmental Kuznets Curve, Granger Causality Test, economic growth
Jel codes: Q43, Q56, C12

1. Introduction

The importance of the environment is gradually increasing in the world economy to have sustainable economic growth. With ever-increasing energy demand, environmental pollution has reached alarming levels globally and has brought global warming and climate change issues to the forefront. Many studies have been done on these issues, and some focused on testing Environmental Kuznets Curve hypothesis. Simon Kuznets (1955) in his study on economic growth and inequality in income distribution, claimed that in the first phase of the per capita income growth, the inequality in income distribution increased gradually, but this imbalance disappeared over time as the economic growth proceeded. In his study, Kuznets put forward that there was an inverse-U-shaped relationship between two parameters, namely economic growth and income distribution (Kuznets, 1955). Inspired by the work of Kuznets, Panayotou (1993) examined the relationship between economic growth and environmental pollution, and called that as Environmental Kuznets Curve hypothesis (Dinda, 2004). According to the hypothesis, there is an inverted-U-shaped relationship between environmental degradation and economic growth, similar to the Kuznets curve. The Environmental Kuznets Curve is shown in Graph 1.



Graph 1. Environmental Kuznets Curve

Source: Panayotou, Economic Growth and the Environment, 2003.

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When looking at the graph, environmental degradation was at low levels since economic activities were much more limited in the pre-industrialized period than in industrialized societies. In the first years of industrialization, environmental pollution increased with inefficient use of resources. However, after a certain turning point, as the industrialization process was completed, environmental pollution would decrease due to the increasing level of knowledge and technological advances (Panayotou, 1993).

The main purpose of this study is to test the validity of the EKC hypothesis for Türkiye by examining the relationship between economic growth, environmental pollution and energy consumption. For this purpose, Türkiye's CO_2 emissions between the period of 1960-2015 was used as an indicator of environmental degradation, and per capita income was used as an indicator of economic growth. The stationarity levels of the variables were examined using the Augmented Dickey Fuller (ADF) and Phillips Perron (PP) unit root tests, and the existence of a causal relationship between the variables was investigated by Granger's causality analysis. The empirical findings obtained will lead to the development of policy recommendations for the Turkish economy.

2. Literature Review

Researches on the validity of the Environmental Kuznets Curve hypothesis have obtained different results due to the diversity of variables, periods or preferred econometric methods.

Grossman and Krueger (1991) conducted the first study on the relationship between economic growth and environmental degradation based on the work of Kuznets (1955). The relationship between the sulfur dioxide (SO_2) emissions, suspended particulate matter and dark matter variables, used as proxy for air pollution, and economic growth was examined by panel data analysis method. As a result of the analysis, they found an inverted-U-shaped relationship between air pollution and economic growth.

The Environmental Kuznets Curve hypothesis was defined for the first time in the study of Panayotou (1993) on 55 developed and developing countries. In the study, they preferred the use of sulfur dioxide (SO_2), nitrogen oxide (NO_x), suspended particulate matter (SPM) and applied the ordinary least squares (OLS) method. As a result of the analysis, they obtained a result confirming the EKC hypothesis.

Ulucak and Bilgili (2018) tested the validity of the EKC hypothesis with the variables of ecological footprint (EF), trade openness, human capital and biological capacitance for 15 countries. In the research conducted using the 1970-2016 period data, an inverted-U-shaped relationship was found between economic growth and ecological footprint.

Ansari et al. (2020) conducted a panel data analysis for 37 Asian countries using ecological footprint data for the period 1991-2017. According to the results of the analysis, while the EKC hypothesis was valid for the Central and East Asian countries, it was found to be invalid for the West, South and Southeast Asian countries.

3. Model and Data Set

In the study, annual time series data of Türkiye between the period of 1960-2015 were used in order to investigate the relationship between environmental pollution, energy consumption and economic growth. As an indicator of environmental pollution, the amount of carbon dioxide emissions (CO2, metric tons per capita) was used, and GDP per capita was used as an indicator of economic growth. GDP product values were calculated in US dollars based on the year 2010 (GDP, constant 2010 US dollars). A full logarithmic regression equation was created by taking the logarithm of each variable and the relationship between the variables was analyzed in quadratic form. In order to investigate the relationship of economic growth with environmental pollution, the model was set up in a quadratic form. The mathematical representation of the regression equation is as follows:

$$lnCO_{2t} = \beta_0 + \beta_1 lnGDP_t + \beta_2 (lnGDP)_t^2 + \beta_3 lnE_t + \varepsilon_t$$

Where, β_0 is the constant term and ε_t is the error term. The β_1 coefficient shows the elasticity of carbon emissions per capita ($lnCO_{2t}$) on the variable of GDP per capita ($lnGDP_t$). The β_2 coefficient shows the extent and direction of the square of the GDP per capita variable ($(lnGDP)_t^2$) to affect the carbon emission per capita. The β_3 coefficient also shows the effect of per capita energy consumption (lnE_t) on carbon emissions per capita.

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$lnCO_2$: Natural logarithm of per capita CO_2 emissions

lnE: Natural logarithm of energy use per capita

lnGDP: Natural logarithm of Gross Domestic Product per capita

$lnGDP^2$: Natural logarithm the square of Gross Domestic Product per capita

Note: All data are obtained from the World Bank (WB) database.

4. Findings and Discussion

In order to obtain statistically significant relationships between variables in time series data, first the stability of the series needs to be checked since there might be irregularities in the course of the series caused by trend, seasonality or cyclical fluctuations. For this purpose, Augmented Dickey-Fuller (ADF) and Phillips Perron (PP) unit root tests were performed to the series.

Table 1: ADF and PP unit-root test

Variables		**ADF (Level)**	**ADF (Difference 1)**	**PP (Level)**	**PP (Difference 1)**
$lnCO_2$	t-stat: probe: Signif:	-2.5241 *0.3159* n0	-8.2358 *0.0000* ***	-2.5926 *0.2852* n0	-8.1991 *0.0000* ***
lnE	t-stat: probe: Signif:	-2.5141 *0.3205* n0	-7.2614 *0.0000* ***	-2.5675 *0.2962* n0	-7.2961 *0.0000* ***
lnGDP	t-stat: probe: Signif:	-2.1843 *0.4885* n0	-7.2558 *0.0000* ***	-2.3113 *0.4209* n0	-7.2558 *0.0000* ***
$LnGDP^2$	t-stat: probe: Signif:	-1.8629 *0.6600* n0	-7.2253 *0.0000* ***	-1.9894 *0.5940* n0	-7.2252 *0.0000* ***

Note: The value in parentheses for the ADF test shows the number of delays selected according to the SIC criterion. The maximum delay length is taken as 10.

Note: (***) Significant at 5%; and (no) means Not Significant. MacKinnon (1996) one-sided p-values

Note: The fixed and trending model has been examined, both at the stabilized level and at the 1st order difference.

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Null hypothesis for ADF and PP unit root tests (H_0) express the existence of a unit root, that is, the series is not stationary. Since all the variables considered become stationary at the same level, the relationship between these variables can be analyzed by the Granger (1969) causality test.

Table 2: Granger(1969) Causality test

Causal Relationship Delay Length: 2	**F-stat**	**Probe**	**H_0: does not Granger Cause**
dlnE→dlnCO_2	2.08932	0.1349	H_0 Accepted
dlnCO_2→dlnE	1.70087	0.1933	
dlnGDP→dlnCO_2	0.71938	0.4922	H_0 Accepted
dlnCO_2→dlnGDP	0.53460	0.5894	
dlnGDP^2→dlnCO_2	0.80621	0.4525	H_0 Accepted
dlnCO_2→dlnGDP^2	0.38147	0.6849	
dlnGDP→dlnE	0.54397	0.5840	H_0 Accepted
dlnE→dlnGDP	0.99140	0.3785	
dlnGDP^2→dlnE	0.52512	0.5948	H_0 Accepted
dlnE→dlnGDP^2	1.012254	0.3709	

In the analysis, the appropriate delay length was considered as 2. According to the results of the Granger causality analysis, the existence of a causality relationship between the variables could not be determined. The EKC hypothesis has not been found to be valid for the Turkish economy.

The results of the studies carried out on this subject differ depending on the time period covered, the data used or the econometric method applied. While some studies have come to the conclusion that the EKC hypothesis had validity for the Turkish economy, some other studies found the hypothesis invalid. For example, Albayrak and Gökçe (2015) concluded that the EKC hypothesis was valid for the Turkish economy with the time series data of 1975-2010 years. On the other hand, Başar and Temurlenk (2007) investigated the validity of the EKC hypothesis in cubic form for the data of Türkiye for the period 1950-2000 in their study and came to the conclusion that the hypothesis was not valid.

The reasons why the EKC hypothesis is invalid for the Turkish economy can be explained as follows. At the beginning of the economic growth and development process, where Türkiye has not yet achieved a high growth rate, CO_2 emission levels have not increased, as it has produced electricity from hydroelectric power plants instead of fossil fuels with high carbon dioxide emissions. However, the progress of the economic growth and development process in Türkiye has been achieved by increasing the number of fossil fuels included in the production process. For this reason, despite the economic growth, environmental degradation did not decrease as predicted by the EKC hypothesis, on the contrary, CO_2 emissions increased.

5. Conclusion

The environmental Kuznets curve is a hypothesis based on the fact that the environmental problems of the countries will decrease with the realization of their economic growth. In this study, the validity of the EKC hypothesis for the Turkish economy was examined with time series belonging to the period of 1960-2015. As a result of the analysis made using the Granger causality test, no causal link was found between the variables of CO_2 emission, energy consumption and per capita income in the period 1960-2015 in Türkiye. In this case, it has been concluded that the Environmental Kuznets Curve Hypothesis was not valid for the Turkish economy.

As predicted by the EKC hypothesis, environmental degradation does not decrease spontaneously as economic growth increases in Türkiye. In this case, governments in developing countries such as Türkiye should also take

additional measures. While realizing the economic growth and development goals, it should shape the energy matrices in favor of renewable energy with the developing technology and knowledge. Economic policies should also focus on growth without sacrificing the environment by taking environmental costs into account. In this process, support such as subsidy benefits or tax deductions is of great importance to encourage the use of renewable energy sources. All of these will contribute to economic growth while improving the quality of the environment.

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