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Article

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Testing the Environmental Kuznets Curve Hypothesis in BRIC Countries

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ABSTRACT

The relationship between economic growth and the environment is an issue that economists have emphasized in recent years. As the effects of environmental problems such as global warming, air pollution, increased use of natural resources, and CO_2 emissions have been felt especially since the 1990s, environmental and energy issues have become of primary importance in the field of economic growth in international platforms. For this reason, environmental problems constitute the main agenda in the international arena today. The work of Kuznets (1955) has an important place in this field. In this study, it is aimed to test the Environmental Kuznets Curve hypothesis for the period covering 1980–2021 in BRIC (Brazil, Russia, India and China) countries. For this purpose, panel cointegration analysis was performed in the study, and according to the results, it was observed that the EKC hypothesis is not valid for BRIC countries and there is a U-shaped relationship between economic growth and CO_2 emissions.

Keywords: BRIC, Environmental Kuznets Curve, Energy Consumption, Pedroni Cointegration.
JEL Classifications: C23, O44, Q43, Q56

1. INTRODUCTION

The environmental degradation occurring throughout the world and the decreasing environmental quality and reaching the dimensions that threaten future generations have recently increased the interest in the environment. The environment interacts with the economy as well as with many other fields. Economic growth harms nature through air pollution and environmental degradation, while environmental degradation increases the cost of economic development. The Environmental Kuznets Curve (EKC) hypothesis also tries to explain the relationship between environmental degradation and economic growth, which has been the subject of long-term debates. The EKC hypothesis states that there is an inverted-U-shaped relationship between environmental degradation and per capita income.

The EKC hypothesis states that CO_2 emissions will increase with the increase in income up to a certain income or development level (which is the scale effect), then, as this income or development level increases, CO_2 emissions will not increase, on the contrary, they will decrease with the structural and technological effect. At first glance, there was a perception regarding the EKC hypothesis that CO_2 emissions in countries were associated with economic growth. However, the level of CO_2 emission in countries does not only change depending on economic growth, but also depends on factors such as energy consumption, openness and financial development (Ang, 2007; Sadorsky, 2010; Ozatac et al., 2017; Ali et al., 2021; Zhang, 2021). It is seen that more satisfactory results regarding the EKC hypothesis are obtained by the inclusion of these variables in the analysis.

According to Kuznets, in the early stages of development, income distribution becomes more and more unequal, and this deterioration in income distribution starts to improve after a certain threshold level. In the EKC hypothesis, which is put forward similar to Kuznets' view, it is seen that the variable of income distribution disorder is replaced by the variable of environmental deterioration. According to the hypothesis, economic growth primarily causes environmental degradation, but after the per capita income of the country reaches a certain level, environmental degradation decreases and the process reverses (Kuznets, 1955). This inverse-U-like relationship between income distribution and income level paved the way for the emergence of the EKC. This issue was adapted to the environment in the 1990s and reconsidered in some studies based on the relationship between per capita income and environmental quality (Grossman and ve Krueger, 1991; Shafik, 1994; Panayotou, 1993; Seldon and Song, 1994).

The aim of this study is to test the validity of the EKC hypothesis with the relationship between energy consumption, environmental pollution (CO_2 emissions) and per capita income level for BRIC (Brazil, Russia, India and China) countries. For this purpose, the study consists of 4 parts. After the introduction, a review of the relevant literature is included. After the literature review on the subject, the data set, model and methodology of the study are explained. Afterwards, the empirical findings are evaluated, and the last part consists of the conclusion.

2. LITERATURE REVIEW

The EKC takes its name from the work of Kuznets (1955), who suggested a similar relationship between income inequality and economic development. The first empirical studies of the EKC were those by Grossman and ve Krueger (1991), Shafik and ve Bandyopadhyay (1992), and Panayotou (1993). Subsequently, many studies have been published in the related literature following these studies. A summary of these studies is shown in Table 1. When we look at the table, it is seen that different results have emerged according to the econometric method, time interval and country group used in these studies.

Richmond and Kaufmann (2006) investigated whether the EKC approach is valid for income, energy use and carbon emissions. In the study, it was concluded that the relationship between economic activity, energy use and carbon emissions depends on the level of development of the countries. For OECD countries, income and per capita energy use and the milestone calculated for per capita carbon emissions were lower, while for non-OECD countries no relationship was found between income and neither energy use nor carbon emissions. On the contrary, it was seen that the relationship in question was positive for these countries.

Ang (2007) investigated the relationship between CO_2 emissions, income and energy use for France using annual data for the period 1960-2000. In the study, findings supporting the EKC relationship for France were obtained, and it was emphasized that a more satisfactory EKC relationship was detected by including energy data in the analysis.

Narayan and Narayan (2010) tested the EKC hypothesis for the period 1980-2004 using Pedroni cointegration tests for 43 developing countries and found that only for the Middle East and South Asia panels, CO_2 emissions decreased with the increase in income.

Using the panel cointegration approach, Pao and Tsai (2011) discussed the impact of economic growth and financial development on environmental pollution for BRIC countries. The study was conducted using data from other countries for the period 1980–2007, excluding Russia (1997–2007). The results of the analysis confirm that the EKC hypothesis is valid for the BRIC countries. As a result of the causality test, it has been determined that there is a strong bidirectional causality between economic growth and CO_2 emissions, economic growth and energy

Table 1: Summary of the literature on the environmental kuznets curve

Authors	Sample and Period	Method	The EKC hypothesis
Friedl and Getzner (2003)	Australia, 1960–1999	Panel unit root, cointegration, and pooled least squares	N-shaped curve
Ang (2007)	France, 1960–2000	Johansen cointegration and VECM granger causality	Inverted-U relationship
Jalil and Mahmud (2009)	China, 1975–2005	ARDL bound test and VECM	Inverted U-shaped curve
Apergis and Payne (2010)	Commonwealth of ındependent states, 1991–2005	Panel unit root, pedroni cointegration, panel FMOLS and VECM	Results vary according to the sample
Iwata et al. (2010)	France 1960–2003	ARDL	Inverted-U relationship
Lean and Smyth (2010)	5 Asean member countries, 1980–2006	Johansen Fisher panel cointegration, VECM	Inverted U-shaped curve
Saboori et al. (2012)	Malaysia, 1980–2009	ARDL, VECM granger causality	Inverted-U relationship
Shahbaz et al. (2013)	Romania, 1980–2010	ARDL	Inverted-U relationship
Saboori and ve Sulaiman (2013)	Malaysia, 1980–2009	ARDL, VECM granger causality	Inverted-U relationship
Al-Mulali and Ozturk (2016)	27 advanced economies, 1990–2012	Kao cointegration, FMOLS, VECM granger causality	Inverted-U relationship
Özokcu and Özdemir (2017)	26 high-income OECD countries and 52 developing countries, 1980–2010	Driscoll-Kraay	Inverse N relationship (OECD) N-shaped relationship (52 developing countries)
Liu et al.(2020)	G7 countries, 1970–2015	Parametric and semi-parametric panel fixed effects model	Inverted-U relationship
Akadiri and Adebayo (2022)	India, 1970–2018	NARDL model	A positive shock to growth positively affects carbon emissions

Source: Created by the authors. NARDL: Nonlinear latency distributed autoregressive, EKC: Environmental kuznets curve consumption, and one-way causality from energy consumption to CO_2 emissions.

Wang (2013) tried to reveal the factors affecting CO_2 emission in Guangdong province of China by considering the data of 1980–2010 period. Considering the results of the analysis within the framework of the EKC hypothesis, it was determined that the Guangdong province of China is on the left side of the inverted-U-shaped curve, that is, the EKC hypothesis is not valid.

Akadiri et al. (2019), who made a significant contribution to the literature with their studies on the impact of globalization on the environment, examined the impact of globalization on the environment for fifteen selected tourism destinations during the period 1995–2014. The results revealed that tourism and real income have a significant negative effect on CO_2 emissions, while globalization and energy consumption have a significant positive effect on CO_2 emissions.

Akadiri et al. (2020) investigated the effect of electricity consumption and globalization on emissions for the People's Republic of China in the period 1970–2014 with the Bayer and Hanck cointegration test and the Toda-Yamamoto Granger causality test and found that globalization had a negative and significant effect on polluting emissions both in the short and long term. They showed that electricity consumption has a positive and significant effect on pollutant emissions both in the short and long term, income has a positive and significant effect on pollutant emissions in the long run and insignificant in the short run.

Liu et al. (2020) investigated the effects of globalization, renewable energy and economic growth on carbon emissions in G7 countries for the period 1970-2015 using the parametric panel fixed effects model and the semi-parametric panel fixed effects model. They found that the relationship between globalization and CO_2 emissions is in an inverted U shape, an increase in economic output increases CO_2 emissions in a statistically significant way, and renewable energy consumption reduces CO_2 emissions.

Mehmood and Tariq (2020), on the other hand, investigated the relationship between globalization and CO_2 emissions in South Asian countries based on the 1972-2013 annual data. Findings revealed a U-shaped relationship between globalization and CO_2 emissions in Nepal, Afghanistan, Bangladesh, and Sri Lanka, while an inverted U-shaped relationship in Pakistan and Bhutan. In addition, it has been determined that there is a bidirectional causality between globalization and CO_2 emissions in Pakistan, Bangladesh and Nepal.

Akadiri and Adebayo (2022) examined the asymmetrical relationship between financial globalization, non-renewable energy consumption, renewable energy consumption, economic growth and carbon emissions in India for the period 1970-2018 using the Nonlinear Delay Distributed Autoregressive (NARDL) model. They determined that a shock contributes to carbon emissions, while a positive shock to growth affects carbon emissions positively.

3. METHODOLOGY

3.1. Model and Variables

BRIC countries are among the countries with rapidly growing and developing economies. In terms of energy production and consumption, these countries direct the global economy and energy prices. In 2020, BRIC countries alone accounted for approximately 28% of the world's total oil consumption. Among these countries, India (5.3%) and China (16.4%) stand out as the countries with the highest consumption share (Syzdykova et al., 2022). Therefore, BRIC countries are the subject of this study. In line with the studies that analyze the impact of economic development on environmental degradation, the model in this study was created as follows:

$$lnCO_{2it} = \beta_0 + \beta_1 lnec_{it} + \beta_2 lngdp_{it} + \beta_3 lngdp^2{}_{it} + \beta_4 lnop_{it} + \beta_5 lnurb_{it} + \varepsilon_{it} \quad (1)$$

In equation (1), CO_2 refers to carbon dioxide emissions (metric tons per capita), *ec* is energy consumption (kg of oil equivalent per capita), *gdp* is the real gross domestic product per capita, gdp^2 is the square of real gross domestic product per capita, *op* is the openness index (the share of exports and imports in gross domestic product), *urb* is urbanization (the share of urban population in the total population). The data used in the study are annual based and cover the years 1980-2021. The CO_2 emission data used in the analysis were obtained from the US Energy Agency (EIA) database, and all other data were obtained from the World Bank database.

3.2. Panel Cointegration Test

One of the most frequently used panel cointegration tests in the literature was developed by Pedroni (1999). This test allows for heterogeneity of cointegration vectors. The test allows both dynamic and fixed effects to differ between the sections of the panel and also allows for the variation of the cointegrated vector between the sections under the alternative hypothesis. Pedroni proposed 7 different tests against the null hypothesis that there is no cointegrating relationship between the variables. Four of these tests are panel cointegration statistics and the other three are group mean cointegration statistics. Pedroni (1999) first ran the general regression pattern of panel cointegration while calculating seven test statistics:

$$y_{it} = a_i + \delta_i t + \beta_{1i} x_{1i,t} + \beta_{2i} x_{2i,t} + \beta_{Mi} x_{Mi,t} + \varepsilon_{i,t} \quad (2)$$

t in the regression refers to the time dimension on the panel; *i* refers to the horizontal cross-section dimension and *M* refers to the number of variables in the regression. Pedroni followed four steps in a nutshell to calculate the seven cointegration statistics. In the first step, the panel made a general regression estimate of the cointegration, made sure that the constant, the time trend and the common dummy variables that should be included in the regression were included in the regression, and then calculated the residuals for later use.

In the second step, the differences of the original series were taken for each cross section and the residuals were calculated for each regression

Table 2: Cross-section dependency test results

Tests	$lnCO_2$	lnec	lngdp	$lngdp^2$	lnop	lnurb
Breusch and Pagan (1980) LM test	476.1 (0.000)	284.3 (0.000)	94.48 (0.000)	752.5 (0.000)	94.12 (0.000)	81.73 (0.000)
Pesaran *et al*. (2008) LM test	221.6 (0.000)	124.9 (0.000)	80.63 (0.000)	361.2 (0.000)	80.29 (0.000)	68.41 (0.000)

Table 3: Pesaran panel unit root test results

Variables	Models	Level		1st difference	
		$\bar{t}$	Percentage 5	$\bar{t}$	Percentage 5
$lnCO_2$	Intercept	−2.134	−2.330	−3.407*	−2.330
	Intercept and trend	−2.336	−2.830	−3.280*	−2.830
lnec	Intercept	−1.751	−2.330	−5.044*	−2.330
	Intercept and trend	−1.818	−2.830	−5.302*	−2.830
lngdp	Intercept	−1.247	−2.330	−4.632*	−2.330
	Intercept and trend	−1.053	−2.830	−3.921*	−2.830
$lngdp^2$	Intercept	−0.975	−2.330	−2.948*	−2.330
	Intercept and trend	−0.701	−2.830	−3.468*	−2.830
lnop	Intercept	−1.692	−2.330	−4.754*	−2.330
	Intercept and trend	−1.895	−2.830	−4.851*	−2.830
lnurb	Intercept	−2.173	−2.330	−5.247*	−2.330
	Intercept and trend	−2.541	−2.830	−4.545*	−2.830

The * sign indicates significance

Table 4: Pedroni cointegration test results

Statistics	No trend		Trend	
	Statistics	P	Statistics	P
Panel v-statistic	−0.167	0.998	−1.097	0.803
Panel rho-statistic	2.765	0.590	4.017	0.210
Panel PP-statistic	−5.986	0.000	−6.013	0.000
Panel ADF-statistic	−6.097	0.000	−8.218	0.000
Group rho-statistic	5.003	0.209	4.707	0.540
Group PP-statistic	−9.998	0.000	−10.502	0.000
Group ADF-statistic	−7.949	0.000	−8.109	0.000

differentiated as $\Delta y_{i,t} = \beta_{1i}\Delta x_{1i,t} + \beta_{2i}\Delta x_{2i,t} + i\beta_{Mi}\Delta x_{Mi,t} + n_{i,t}$. In the third step, he calculated L^2_{11i}, the long-term variance of $n_{i,t}$ in the previous step, using any kernel estimator, such as the Newey-West (1987) estimator. In the fourth step, he used the remnants of the original regression obtained in the first step in two different ways for parametric and non-parametric statistics. For non-parametric statistics, $e_{i,t}=\gamma_i e_{i,t-1}+u_{i,t}$ was estimated and the long-term variance of n was calculated using the obtained residuals. The obtained variance was symbolized by σ_i^2 and the formula $\lambda_i = \frac{1}{2}(\sigma_i^2 - S_i^2)$ was calculated. Here the expression S_i^2 expresses the simple variance of $u_{i,t}$. For parametric statistics, the simple variance is calculated using the formula $e_{i,t} = \gamma_i e_{i,t-1} + \sum_{k=1}^{K_i}\gamma_{i,k}\Delta e_{i,t-k} + u_{i,t}$ by applying the formula and using residuals.

Taking into account the possible correlation between the differences of the constant term, the error term, and the explanatory variables, this test also allows for a large degree of heterogeneity between individual cross-sections. The non-parametric adaptation in this method corrects the autocorrelation and endogenity problem, and the long-term coefficients are estimated by regressing the adjusted dependent variable on the independent variables. Average group FMOLS long-term coefficients are obtained by averaging the group estimates. Pedroni (2000), testing the power of this test on small samples with Monte Carlo simulations, stated that the FMOLS test has good power on small samples. Pedroni stated that the error term is stationary with the asymptotic covariance matrix, based on the following formulas, which are the general equation of panel cointegration.

$$\gamma_{i,t} = \alpha_i + \beta x_{i,t} + \mu_{i,t}$$

$$x_{i,t} = x_{i,t-1} + \varepsilon_{i,t} \tag{3}$$

In this case, the variables for each cross-section in the panel are cointegrated with the cointegration vector. The panel FMOLS estimator is calculated as follows:

$$\beta^*_{NT} = N^{-1}\sum_{i=1}^{N=1}\left(\sum_{t=1}^{T}(x_{it}-x_i)^2\right)^{-1}\left(\sum_{t=1}^{T}\left(x_{it}-x_i\right)Y^*_{it} - T\tau_i\right) \tag{4}$$

$$Y^*_{it} = \left(Y_{it} - Y_i\right) - \frac{L_{21i}}{L_{22i}}\Delta x_{it} \tag{5}$$

$$\tau_i = \Gamma_{21i} + \Omega^0_{21i} - \frac{L_{21i}}{L_{22i}}(\Gamma_{22i} + \Omega^0_{22i}) \tag{6}$$

4. ANALYSIS FINDINGS

For the model in which the effects of per capita income, energy consumption, openness index and urbanization rate, which are economic development indicators, on carbon dioxide emissions, which are considered as environmental indicators, were examined, firstly, a cross-section dependency test was performed. Breusch and Pagan (1980) and Pesaran et al. (2008) tests were preferred. The results obtained are presented in Table 2. According to the results, the H_0 hypothesis, which shows the cross-section independence for the variables in the BRIC countries, is rejected at 99% confidence level. This result shows that there is a cross-sectional dependence among the individuals forming the panel.

After determining the cross-sectional dependence, it is very important to determine whether the series used have a unit root in

Table 5: Panel FMOLS test results

Country	Consumption	*lnec*	*lngdp*	*lngdp²*	*lnop*	*lnurb*
Brazil	−284.92* (−2.05)	0.78 (1.35)	49.21** (2.12)	−2.35* (−2.05)	−0.20 (−1.02)	6.18 (1.11)
Russia	28.75 (0.82)	1.32*** (10.87)	38.42*** (3.02)	−1.81*** (−2.95)	−0.10 (−1.01)	1.45** (0.45)
India	−299.52 (−0.96)	1.40*** (3.49)	35.09 (0.68)	−1.65 (−0.66)	0.32* (1.89)	0.44** (0.10)
China	−3.82 (−0.57)	1.23*** (17.19)	−1.10 (−0.96)	0.05 (1.04)	−0.01 (−0.42)	0.46 (1.57)
Panel	31.70 (0.01)	0.75*** (38.20)	−0.38*** (−21.67)	0.06*** (4.87)	0.02 (0.97)	0.30*** (13.04)

***, ** and * indicate 1%, 5% and 10% significance levels, respectively

terms of the reliability of the analysis results. This shows that second generation panel unit root tests should be used, which takes into account the cross-sectional dependency within the scope of the research. The table below shows the results of the Pesaran (2007) panel unit root test, which takes into account the cross-sectional dependence. Here, CADF test results for both constant term and constant term and trend cases are shown, and $\overline{t}$ (t-bar) statistic value and critical values at 95% confidence level are given.

It can be seen from Table 3 that the level values of the series are not stationary as a result of the unit root test. This means that the shock effects on the series do not disappear over time. When the first difference of the variables is taken, they become stationary according to all statistical test values, that is, they carry the I (1) process. Since the same order of stationarity is detected, cointegration analysis can be started. Panel cointegration test developed by Pedroni (1999) was used in the study to detect the existence of a long-term relationship between all dependent and independent variables used in the model. In this test developed by Pedroni, seven different test statistics were used to test the existence of the cointegration relationship. As a result of the test, there are seven test statistics, four of which are within the within dimension, and the others are the between dimension. Pedroni cointegration test results are given in the Table 4. The test statistics of Panel PP, Panel ADF, Group PP and Group ADF prove that the H_0 hypothesis that there is no cointegration for BRIC countries is rejected and there is a long-run cointegration relationship between the variables.

After determining the existence of the cointegration relationship, the Panel FMOLS method developed by Pedroni (2000) is used to determine the cointegration vector coefficients. The panel FMOLS result for the BRIC countries and the results for each cross-section are shown in Table 5.

When the group panel results are examined, it is seen that the coefficient of the *lngdp* series has a negative sign and the *lngdp²* series has a positive sign. According to these results, the inverted-U-shaped EKC hypothesis is not valid for BRIC countries. In other words, there is a U-shaped relationship between environmental pollution and national income in BRIC countries. Looking at the *lnec* series, it is seen that it is statistically significant at the 1% significance level and its coefficient is positive. A 1% increase in energy consumption per capita increases CO_2 emissions per capita by 0.75%. It has been concluded that the *lnop* series parameter used to represent the openness index is statistically insignificant for the BRIC countries used in the analysis. The long-term coefficient of the *lnurb* series has a positive sign and is statistically significant. According to the panel FMOLS test, a 1% increase in urbanization rate increases the carbon dioxide emission level by 0.30% for BRIC countries.

It is seen that the *ec* series, which is used to represent energy consumption per capita, is generally statistically significant and has a positive sign. This shows that energy consumption has a direct and increasing effect on environmental pollution. It is observed that energy consumption increases the level of carbon dioxide emissions in BRIC countries. The 1% increase in energy consumption per capita in Brazil, Russia, India and China, which are in this country group, increased the CO_2 emission level by 0.78%, 1.32%, 1.40% and 1.23%, respectively.

When the long-term coefficients of the *lngdp* and *lngdp²* series for each cross-section were examined, it was found to be statistically significant in the BRIC countries. Among these countries, Brazil and Russia, the coefficient of national income per capita is positive, the coefficient of the *lngdp²* series, which is the square of the national income per capita, has a negative sign and is statistically significant. In other words, the inverted-U-shaped EKC hypothesis is valid in these countries. When the coefficients of the openness index, which is considered as one of the economic development indicators, are examined for each section, it is seen that this coefficient is significant only for India. In India, the openness index has a carbon dioxide-increasing effect. Looking at the long-term parameters of the *lnurb* series, it is concluded that urbanization has an increasing effect on environmental pollution in Russia and India. In Brazil and China, the effect of urbanization on carbon dioxide emissions, which is considered as an indicator of environmental pollution, is statistically insignificant.

5. CONCLUSION

In this study, the relationship between energy consumption, gdp, gdp squared, trade openness, urbanization and CO_2 emissions was analyzed for the BRIC countries for the period covering the years 1980-2021. According to the results of panel data analysis, it was determined that there is a long-term relationship between these variables. According to the results of the analysis, it was observed that the EKC hypothesis is not valid for the BRIC countries and there is a U-shaped relationship between economic growth and CO_2 emissions. Contrary to the EKC hypothesis in the BRIC countries, it was concluded that environmental pollution decreased with the increase in economic growth at first, and then after a certain point, environmental pollution increased with the increase in economic growth. In this case, it can be interpreted that after a certain point in the BRIC countries, an economic growth path that leaves environmental sensitivity in the background. When the coefficients for each country are examined, the 1% increase in energy consumption per capita in Brazil, Russia, India and China increased the level of CO_2 emissions by 0.78%, 1.32%, 1.40% and 1.23%, respectively. The effect was statistically insignificant.

According to the results of the analysis, it is seen that there is a strong relationship between economic growth and energy consumption and environmental pollution. Governments need to encourage cleaner economic activities and R&D expenditures for environmentally friendly technologies, along with structural changes for a cleaner environment. In addition, it is necessary to implement policies to increase the share of renewable energy sources, which cause less carbon emissions and are considered more environmentally friendly, in the total energy portfolios of countries.

REFERENCES

Akadiri, S.S., Adebayo, T.S. (2022), Asymmetric nexus among financial globalization, nonrenewable energy, renewable energy use, economic growth, and carbon emissions: Impact on environmental sustainability targets in India. Environmental Science and Pollution Research, 29(11), 16311-16323.

Akadiri, S.S., Alola, A.A., Bekun, F.V., Etokakpan, M.U. (2020), Does electricity consumption and globalization ıncrease pollutant emissions? Implications or environmental sustainability target for China. Environmental Science and Pollution Research, 27, 25450-25460.

Akadiri, S.S., Lasisi, T.T., Uzuner, G., Akadiri, A.C. (2019). Examining the ımpact of globalization in the environmental Kuznets curve hypothesis: The case of tourist destination states. Environmental Science and Pollution Research, 26, 12605-12615.

Ali, M.U., Gong, Z., Ali, M.U., Wu, X., Yao, C. (2021), Fossil energy consumption, economic development, inward FDI impact on CO_2 emissions in Pakistan: testing EKC hypothesis through ARDL model. International Journal of Finance & Economics, 26(3), 3210-3221.

Al-Mulali, U., ve Ozturk, I. (2016), The investigation of environmental Kuznets curve hypothesis in the advanced economies: The role of energy prices. Renewable and Sustainable Energy Reviews, 54, 1622-1631.

Ang, J.B. (2007), CO 2 emissions, energy consumption, and output in France. Energy Policy, 35(10), 4772-4778.

Apergis, N., Payne, J.E. (2010), Renewable energy consumption and growth in Eurasia. Energy Economics, 32(6), 1392-1397.

Breusch, T.S., Pagan, A.R. (1980), The Lagrange multiplier test and its applications to model specification in econometrics. The Review of Economic Studies, 47(1), 239-253.

Friedl, B., Getzner, M. (2003), Determinants of CO_2 emissions in a small open economy. Ecological Economics, 45(1), 133-148.

Grossman, G.M., ve Krueger, A.B. (1991), Environmental impacts of a North American free trade agreement (No. w3914). National Bureau of Economic Research.

Iwata, H., Okada, K., ve Samreth, S. (2010), Empirical study on the environmental Kuznets curve for CO 2 in France: The role of nuclear energy. Energy Policy, 38(8), 4057-4063.

Jalil, A., Mahmud, S.F. (2009), Environment Kuznets curve for CO_2 emissions: A cointegration analysis for China. Energy Policy, 37(12), 5167-5172.

Kuznets, S. (1955), "Economic growth and income equality." American Economic Review 45(1), 1-28.

Lean, H.H., Smyth, R. (2010), CO_2 Emissions, electricity consumption and output in ASEAN. Applied Energy, 87(6), 1858-1864.

Liu, M., Ren, X., Cheng, C., Wanga, Z. (2020), The role of globalization in CO_2 Emissions: A semiparametric panel data analysis for G7. Science of the Total Environment, 718, 137379.

Mehmood, U., Tariq, S. (2020), Globalization and CO_2 emissions nexus: Evidence from the EKC hypothesis in South Asian countries. Environmental Science and Pollution Research, 27(29), 37044-37056.

Narayan, P.K., Narayan, S. (2010), Carbon dioxide emissions and economic growth: Panel data evidence from developing countries. Energy Policy, 38(1), 661-666.

Ozatac, N., Gokmenoglu, K.K., Taspinar, N. (2017), Testing the EKC hypothesis by considering trade openness, urbanization, and financial development: The case of Turkey. Environmental Science and Pollution Research, 24, 16690-16701.

Özokcu, S., ve Özdemir, Ö. (2017), Economic growth, energy, and environmental Kuznets curve. Renewable and Sustainable Energy Reviews, 72, 639-647.

Panayotou, T. (1993), Empirical Tests and Policy Analysis of Environmental Degradation at Different Stages of Economic Development (No. 992927783402676). International Labour Organization.

Pao, H.T., Tsai, C.M. (2011), Multivariate Granger causality between CO_2 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), 685-693.

Pedroni, P. (1999), Critical Values for Cointegration Tests in Heterogeneous Panels with Multiple Regressors. Oxford Bulletin of Economics and Statistic,s 61, 653-678.

Pedroni, P. (2000), Fully modified OLS for heterogeneous cointegrated panels. Advances in Econometrics, 15, 93-130.

Pesaran, M.H. (2007), A simple panel unit root test in the presence of cross-section dependence. Journal of Applied Econometrics, 22(2), 265-312.

Pesaran, M.H., Ullah, A., Yamagata, T. (2008), A bias-adjusted LM test of error cross-section independence. The Econometrics Journal, 11(1), 105-127.

Richmond, A.K., Kaufmann, R.K. (2006), Is there a turning point in the relationship between income and energy use and/or carbon emissions? Ecological Economics, 56(2), 176-189.

Saboori, B., Sulaiman, J., ve Mohd, S. (2012), Economic growth and CO 2 emissions in Malaysia: A cointegration analysis of the environmental Kuznets curve. Energy Policy, 51, 184-191.

Saboori, B., ve Sulaiman, J. (2013), Environmental degradation, economic growth and energy consumption: Evidence of the environmental Kuznets curve in Malaysia. Energy Policy, 60, 892-905.

Sadorsky, P. (2010), The impact of financial development on energy consumption in emerging economies. Energy Policy, 38(5), 2528-2535.

Seldon, T. M., Song, D. (1994), Environmental quality and development: Is there a Kuznets curve for air Ž. pollution. Journal of Environmental Economics and Management, 27, 147162.

Shafik, N. (1994), Economic development and environmental quality: An econometric analysis. Oxford Economic Papers, 46, 757-773.

Shafik, N., ve Bandyopadhyay, S. (1992), Economic Growth and Environmental Quality: Time-Series and Cross-Country Evidence (Vol. 904). Policy Research, Working Papers. The World Bank.

Shahbaz, M., Mutascu, M. ve Azim, P. (2013), Environmental Kuznets curve in Romania and the role of energy consumption. Renewable and Sustainable Energy Reviews, 18, 165-173.

Syzdykova, A., Abubakirova, A., Kudabayeva, L., Zhantayeva, A., Omarova, A. (2022), Asymmetric causality relationship between oil prices and inflation in BRIC countries. International Journal of Energy Economics and Policy, 12(3), 184-191.

Wang, Y.C. (2013), Functional sensitivity of testing the environmental Kuznets curve hypothesis. Resource and Energy Economics, 35(4), 451-466.

Zhang, J. (2021), Environmental Kuznets curve hypothesis on CO_2 emissions: evidence for China. Journal of Risk and Financial Management, 14(3), 93.