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Evaluation of the Relationship between Energy Consumption, Economic Growth, and Carbon Emissions in the Context of the N-Shaped Environmental Kuznets Curve: Newly Industrialized Countries (NICs)

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Abstract

Climate change and environmental degradation have become an issue that has focused on the whole world in recent years. In many studies on this subject, the existence of an inverted U-shaped Kuznets Curve has been analyzed. In this study, a model was established to analyze the N-shaped Kuznets Curve in order to see the long-term position of the relation between economic growth andenvironmental degradation. New industrialized Countries (NICs), which have a substantial effect on world carbon emissions, are also discussed in the study. Panel data analysis was used to examine the relationship between environmental degradation and economic growth over the period from 1970 to 2019.In the analysis, first of all, the cross-section dependence (CSD) was tested and it was decided that the second-generation tests would be continued according to the results. In the subsequent Westerlund hand-integration analysis, it was concluded that there was co-integration between the series and that they would act together in the long run. Finally, the CCE method, which is one of the long-term estimators, was used and analyzes were carried out by establishing three different models. As a result of the analysis, it was concluded that energy consumption positively affects carbon emissions, the existence of an inverted U-shaped Kuznets Curve for the entire panel and the existence of an N-shaped Kuznets Curve throughout the panel could not be proven.

Keywords: *Energy Consumption, Economic Growth, Environmental Kuznets Curve, Carbon Emission.*

Enerji Tüketimi, Ekonomik Büyüme ve Karbon Emisyonları İlişkisinin N-Şekilli Çevresel Kuznets Eğrisi Bağlamında Değerlendirilmesi: Yeni Sanayileşmiş Ülkeler (NICs)

Özet

İklim değişikliği ve çevresel bozulma son yıllarda tüm dünyanın üzerinde yoğunlaştığı bir konu haline gelmiştir. Bu konuya yönelik olarak yapılan birçok çalışmada Ters U şeklinde Kuznets eğrisinin varlığı analiz edilmiştir. Bu çalışmada çevresel bozulma ve ekonomik büyüme arasındaki ilişkinin uzun vadedeki pozisyonunu görebilmek için N şekilli Kuznets Eğrisini de analiz etmeye yönelik model kurulmuştur. Çalışmada ayrıca dünya karbon emisyonuna ciddi oranda etkide bulunan yeni sanayileşmiş ülkeler (NICs) ele alınmıştır. 1970'ten 2019'a kadar geçen süre içinde çevresel bozulma ve ekonomik büyüme arasındaki ilişkiyi incelemek için panel veri analizi kullanılmıştır. Analizde öncelikle yatay kesit bağımlılığı (CSD) test edilmiş ve sonuçlara göre ikinci nesil testleri ile devam edileceği kararına varılmıştır. Ardından yapılan Westerlund eşbütünleşme analizinde seriler arasında eşbütünleşme olduğu ve uzun dönemde birlikte hareket edecekleri sonucu elde edilmiştir. Son olarak uzun dönem tahmincilerinden CCE metodu kullanılmış ve üç ayrı model kurularak analizler gerçekleştirilmiştir. Analizler neticesinde enerji tüketiminin karbon emisyonunu pozitif yönde etkilediği, panelin geneli için ters U şeklinde Kuznets Eğrisinin varlığının ve yine panelin genelinde N şekilli Kuznets eğrisinin varlığının kanıtlanamadığı sonuçlarına ulaşılmıştır.

Anahtar Kelimeler: *Enerji Tüketimi, Ekonomik Büyüme, Çevresel Kuznets Eğrisi, Karbon Emisyonu.*

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INTRODUCTION

In recent years, climate change and environmental degradation have become a topic of discussion around the globe. In studies on global climate change, animportant increase in greenhouse gas emissions resulting from fossil fuel consumption and economic developmenthas been revealed many times in the last century(Liu et al., 2020). Carbon dioxide emissions (CO_2) account for about 75% of greenhouse gas emissions, increasing the global temperature by a relatively high 1.5◦C. The rapid increase in carbon emissions in the atmosphere can have devastating consequences for humanity, such as air quality, human health, and negatively affected economic growth, as well as serious changes such as climate problems and environmental degradation (Machol and Rizk, 2013).

Energy-related innovations and the growth in the quantity and quality of energy play akey position in economic development. Furthermore, energy is important in explaining the Industrial Revolution. With the emergence of the Industrial Revolution, there has been a significant increase in production and this increase has brought energy consumption with it (Stern & Kander, 2012; Rahman et al., 2021). The increase in energy usage in Newly Industrialized Countries (NICs) has contributed greatly to the progress of industrialization. The NICs are South Africa, India, Malaysia, Thailand, Mexico, the Philippines, Indonesia, Turkey, Brazil and China. There are concerns and questions about how situations such as overurbanization and intense industrialization in these developing countries will reflect on energy consumption (Sadorsky, 2014; Yang et al., 2022).

It has been suggested that there is an inverted U-shaped relationship between income growth and environmental degradation. The starting point of the Environmental Kuznets Curve(EKC) is that the output is very high in the early stages of the economy's growth and the income level increases significantly, but these developments cause environmental degradation in the later periods (Grossman & Krueger,1995). The growth of the economy brings with it the demand for traditional energy sources such as oil, coal and natural gas used for electricity generation. Thus, the output of growth in the economy progressively increases environmental degradation and vice versa (Sarkodie & Strezov, 2018). In this paper, the impact of economic development and energy usage on CO_2 emissions were examined with the EKC, which analyzes the link between environment and economic development, focusing on NICs. Especially recently, the question of whether continued economic growth is causing greater damage to the world's environment is very important (Grossman & Krueger, 1991). Therefore, the environment-economic growth relationship has emerged as a major global concern (Tenaw & Beyene, 2021). Many studies have shown that there is a substantial and positive relationshipbetween the square of per capita income and CO_2 (Bhattarai and Hammig, 2001; Dietz et al., 2012; Hung and Shaw, 2006; Panayotou et al., 2000; Poudel, 2009;).

NICs are the countries that cause the most gas emissions and energy usage in the world. China, one of the NICs was reported as the country generatingutmost CO_2 emissions with 11,680 gigatons in 2020.India,after China,is producing 2,411 gigatons of CO_2 and then Indonesia with 568.27 gigatons of CO_2[1]. Especially, India and China are among the countries with the most crowded population in the world. NICs are also among the most exportation countries such as Mexico, China and India, and all other NICs are among the supreme 50 exportation countries in the world (excluding the Philippines). Brazil is among the top 10 countries in terms of primary energy consumption worldwide in 2021. Mexico is responsible for about 1% of global CO_2 emissions, and the energy sector in Mexico is known as the sector with the largest emissions.

Between 1990 and 2018, greenhouse gas emissions in Mexico increased by 72% (Acosta-Pazmiño et al., 2021).Malaysia has been the country with the highest CO_2 emission due to its economic development since 2008, and accounted for 28% of the world's CO_2 emissions in 2017 (Awan et al., 2022). The South African economy is currently increasing its CO_2 emission drastically due to coal being the source of its energy consumption (Saba, 2023). That's why South Africa is one of the countries emitting the most CO_2, with 1.09 of the world emissions. In 2021, the amount of CO_2 emissions from energy consumption in the Philippines was determined as approximately 136.8 million tons of carbon dioxide. In Thailand during 2000–2013, emissions increased from 156 Mt CO_2eq to 227 Mt CO_2eq, accounting for 2.94 percent of the average growth rate. In 2016, Thailand ranked 18th as a global emitter of greenhouse gas emissions (Pita et al., 2020). In 2018, Turkey was among the 20 countries with the highest CO_2 emission. It ranks 15th in total CO_2 emission and 16th in per capita CO_2 emission (Union of Concerned Scientists, 2020). There is a high demand for energy fuels and resources in these countries. In addition, NICs are the countries that put environmental problems in the background while showing economic performance (Onifade et al., 2021). So, in this study, economic growth in NICs is examined in cubic form and the existence of N-shaped EKC is analyzed.

1. LITERATURE REVIEW

In this study, the relationship between carbon emissions, energy consumption and economic growth is investigated. In this part of the study, studies for countries with many NICs are presented. Chen et al. (2019) analyzed the bi-directional causality relationamong long-term renewable energy consumption, CO_2 emissionsand economic development with panel data analysis for China. Empirical results show that in some regions of China, the inverted U-shaped EKC hypothesis is not supported, and in some regions it is only slightly supported. According to Yang and Zhao (2014), trade openness is a significant variable emissions. Similarly, Shahbaz et al. (2013) indicated that economic development and energy consumption augmented carbon emissions but financial growth and trade openness diminished carbon emissions in Indonesia. Rahman and Kashem (2017) showed a directly proportional of energy usage on carbon emissions in Bangladesh. Bekun et al. (2018) analyzed that economic development and carbon emissions showed an opposite relationship in South Africa. However, a unidirectional causality was analyzed from energy consumption to CO_2 emissions.

In environmental Kuznets curve estimation, datais generally built in square or cubic form. Grossman and Krueger (1991, 1995) demonstrated the inverted-U-shaped EKC relationship between environmental degeneration and economic development. In the initial phase of the connectionbetweenenvironmental degeneration and economic development, it has been remarked that there is a direct relationship between development and environmental degeneration (Selden & Song, 1994). In addition to this, this relationship turns negative after a certain stage of economic growth. Many studies have revealed the relationship between ecological degradation and economic development, but the results differ from each other. This is due to the fact that different explanatory variables, different periods and different countries or groups of countries are analyzed in studies.

There are studies where the Kuznets curve is N-shaped using different variables. In a study investigating the effect of income disparity on the EKC hypothesis, it was concluded that income inequality changes the relationshipbetween economic development and CO_2 emissions from an inverted U shape to an N shape. In other words, income disparityreevaluate the EKC (Li et al., 2022). In another study testing the EKC for the Weihe River basin using the terrain footprint as anintermediary for environmental degeneration, an N-shaped cubic EKC was identified (Dai et al., 2022). An N-shaped cubic EKC was identified in the study, which analyzed the dissociation between municipal solid waste (MSW) production and economic development in 285 cities in China from 2002 to 2017 (Wang et al., 2021).In another study, the presence of N-shaped EKC was tested among the use of non-renewable and renewable energy usage and environmental sustainability. In this study, N-shaped indicators of environmental degradation such as per capita income and ecological footprint, adjusted net savings,constraint on nature and environmental vulnerability are linked (Fakher et al., 2022).The existence of N-shaped EKC was found in another paper examining fertilizer preservation in China's Hubei province from 1978-2017. Hubei's fertilizer impact indexes rose at first with the rural household income,but diminished later before it started to go up again (Liu et al., 2021).So, in this study firstly, the relationship between environmental degeneration and economic development, the presence of inverse-U EKC, and then the presence of N-shaped EKC in these countries in the long run were analyzed. Analyzing the NICs, which have been among the world's largest emitters of carbon emissions in the last 20 years, is very substantial in the way of understanding the long-term effects of economic development on the ecological system. Moreover, it is thought that the study will be a guide for policymakers, scientists and researchers in these countries in terms of revealing the long-term picture of the ecological balance.

Table 1: Related Literature in The Field

Author(s)	Period	Sample	Methodology	Variables	Conclusion
Alam et al. (2016)	1970- 2012	Brazil	ARDL bounds analyses	Income, energy usage, carbon emissions	Energy usage increases $CO_2$and EKC exists
Bekun et al. (2018)	1960- 2016	South Africa	Co-integration tests	Monetary found, workforce, energy consumption, economic development, carbon emissions	Energy usage and economic development increase Carbon emissions
Yang and Zhao (2014)	1971-2008	India	Time series analyses	Economic development, gross fixed capital formation, trade openness, CO_2emission	Effect of energy usage on carbon emissions and economic development
Chen et al. (2019)	1995- 2012	China	Panel datatests	Renewable energy usage, CO_2 emissions, economic development	Back indication connection among renewable energy, CO_2emissions and economic development
Hossain (2011)	1971-2007	NICs	Panel dataand Granger causality test	CO_2 emissions, trade openness, urbanization, energy usage	Energy usage increases CO_2 emissions
Salman et al. (2019)	1990- 2016	South Korea, Thailand, Indonesia	Panel data analyses	Institutional quality, trade openness, CO_2emission, economic growth	From unidirectional causality, institutional quality and trade openness to CO_2
Rahman et al. (2017)	1960- 2013	UK, Canada, China, Brazil, India, USA	Panel data analysis, time series tests	Trade openness, population growth, CO_2 emissions	Energy consumption increases exports, population density and CO_2emissions
Boontome et al. (2017)	1971- 2013	Thailand	Time series analyses, VECM Granger causality	Renewable energy consumption, carbon emissions, economic development	CO_2 emissions increase economic development
Pata (2018)	1974- 2014	Turkey	CCR FMOLS, ARDL analyses	Urbanization, financial growth, CO_2 emissions	Urbanization and financial growth impact on CO_2 emissions
Aslam et al. (2020)	1971-2016	Malaysia	VECM Granger causality	Carbon emissions, trade openness, gross domestic product, globalization and industrialization	In the short-run, unidirectional causality from economic growth, globalization, industrialization and trade openness to CO_2emissions
Zoundi (2017)	1980-2012	25 African countries	Panel data analysis, robustness tests	Carbon emissions, GDP, renewable energy	Renewable energy usage has the effect of reducing CO_2emissions
Pao and Tsai (2011)	1980-2008	Brazil	Time series analyses	Energy consumption, GDP and CO_2 emissions	Unidirectional causality from GDP to CO_2emissions
Soytas and Sari (2009)	1960–2000	Turkey	Toda and Yamamoto	Energy usage, economic development and CO_2emissions	No causality relationship between gdp and CO_2emissions

Note: Table created by author

2. DATA AND DESCRIPTIVE STATISTICS

In this study, 10 NICs including Brazil, Philippines, Indonesia, India, Malaysia, Turkey, South Africa, Thailand, Mexico and China havebeen analyzed. Energy consumption, carbon emission (CO_2) and gross domestic product per capita (GDP) variables were used in the study. Carbon emission and energy consumption data are attainedfrom the BP World Energy Statistics database. GDP data is obtained from World Bank. Data for each country is collected annually from 1970 to 2019.

2.1. Empirical Analysis

2.1.1. Cross-Section Dependency Tests

Before starting the analysis of the variables in the panel data, the existence of cross-section dependence should be analyzed. According to the CSD test improved by Pesaran (2004), the presence of cross-sectional dependence among the series will guide the next steps of the analysis and ensure that the results obtained are consistent. Thus, it will be determined whether first-generation or second-generation panel data tests will be performed with respect to the results of the CSD test. The CSD test is as follows:

$$CDLM1=T\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}^{2} \sim X^{2\frac{N(N-1)}{2}} \quad (1)$$

The corrected version is as follows:

$$LM_{adj}=\left(\frac{2}{N(N-1)}\right)^{1/2}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}^{2}\frac{(T-K-1)\hat{\rho}_{ij-\hat{\mu}T_{ij}}^{2}}{\upsilon_{Tij}} \sim N(0,1) \quad (2)$$

In the above equation $\hat{\mu}T_{ij}$symbolises the mean and υ_{Tij}symbolises variance.

According to the equation, the test statistic expresses the standard normal distribution asymptotically (Pesaran et al., 2008).

Hypotheses are:

H_0= Cross-sectional dependence is not observed

H_1= Cross-sectional dependenceis observed.

The cross-section dependency results obtained in this study are shown in Table 2.

Table 2: Testing Cross-Sectional Dependency

Variables	CO_2	Energy	Gdp	Gdp ^2	Gdp^3	Co-integrationEquation
Tests	**Test statistics and p value**					
LM (Breusch-Pagan,1980)	179.5 (0.000)	204.053 (0.000)	165.250 (0.000)	106.242 (0.000)	112.111 (0.000)	106.624 (0.000)
CDLM1 (Pesaran, 2004)	14.188 (0.000)	16.766 (0.000)	12.675 (0.000)	6.455 (0.000)	7.074 (0.000)	6.496 (0.000)
CDLM (Pesaran, 2004)	-3.307 (0.000)	-4.147 (0.000)	-2.506 (0.006)	0.253 (0.400)	0.837 (0.201)	-1.117 (0.132)
LM_{adj}(Pesaran et al., 2008)	59.128 (0.000)	43.090 (0.000)	65.841 (0.000)	81.210 (0.000)	50.888 (0.000)	7.492 (0.000)

According to the results in the table, the results of the variables and the co-integration equation are less than 0.05 probability value, $H_0$is rejected and decided on the presence of cross-section dependence. Thus, in the next step of the analysis, second- generation unit root analysiswill be carried because ofthe existence of cross-sectional dependence.

2.1.2. Panel Unit Root Analysis

Before performing the co-integration analysis, it is necessary to decide the stationarity of the variables used. Because presence of cross-section dependence was determined as a result of the CSD test performed in this study, the second-generation unit root test, the CADF test (Pesaran, 2007) was performed. The CADF test is preferred as it can be used in the case of T > N and T < N as well.

$$Y_{i,t} = (1-\emptyset_i)\mu_i + \emptyset_i y_{i,t-1} + u_{i,t} i = 1,2,,,,,,,Nvet = 1,2,,,,,,,T \quad (3)$$

$$u_{it} = y_i f_t + \varepsilon_{it} \quad (4)$$

f_t expression shows the overall panel that is the unobservable joint effect of each country.ε_{it} shows the error term for each country. The unit root hypothesis is as follow:

$$\Delta y_{it} = \alpha_i + \beta_i y_{i,t-1} + y_i f_t + \varepsilon_{it} i = 1,2,,,,,,Nvet = 1,2,,,,,,T \quad (5)$$

$$H_0: \beta_i = 0 foralli$$

$$H_0: \beta_i < 0, i = 1,2,,,,,,,,,N_1, \beta_i = 0 \; i = N_1 + 1, N_2 + 2,,,,,,,,N.$$

Additionally, CIPS (Cross-Sectionally Augmented IPS) expresses the unit root test statistics for the complete panel, and it can be provided by figuring out the mean of the unit root test statistics of the cross-section or countries (Pesaran, 2007). CIPS statistics is as follows;

$$\text{CIPS}=N^{-1}\sum_{i=1}^{N} CADF_i \quad (6)$$

In table 3, unit root test results for both each country and the panel in general are presented. The table also includes the critical values generated by Pesaran (2007).

Table 3: Panel Unit Root TestResults

Countries Variables	Test Statistics									
	CO_2	Δ CO_2	Energy	ΔEnergy	gdp	Δ gdp	Gdp^2	Δgdp^2	Gdp^3	Δgdp^3
Brazil	-2.89	-3.92**	-3.05***	-4.13*	-3.02***	-4.90*	-2.72	-4.93*	-2.46	-4.90*
China	-2.23	-2.72	-0.69	-2.76	-1.63	-3.01***	-1.81	-2.46	-1.86	-2.11
India	-1.52	-3.62**	-2.17	-4.86*	-1.09	-3.41**	-0.83	-3.23***	-0.61	-3.05**
Indonesia	-3.23	-3.93**	-2.00	-4.42*	-2.17	-5.24*	-2.07	-5.38*	-1.89	-5.38*
Malaysia	-2.00	-4.80*	-2.60	-3.99*	-2.88	-6.32*	-2.84	-6.11*	-2.86	-5.89*
Mexico	-2.49	-4.59*	-0.8901	-3.18***	-2.69	-6.10*	-2.58	-5.95*	-2.51	-5.82*
Philippines	-0.65	-2.92	-1.65	-3.77**	-0.00	-5.18*	-0.29	-5.13*	-0.54	-5.07*
South Africa	-1.60	-3.75**	-2.84	-6.07*	-3.14***	-6.69*	-3.1***	-6.41*	-3.15	-6.05*
Thailand	-1.07	-2.93	-3.28***	-3.97*	-1.71	-3.56**	-1.68	-3.63**	-1.67	-3.70**
Turkey	-2.33	-5.15*	-2.51	-4.33*	-2.16	-4.35*	-2.08	-4.39*	-2.00	-4.39*
Panel (CIPS)	-2.00	-3.83**	-2.17	-4.15*	-2.05	-4.88*	-2.00	-4.76*	-1.96	-4.64*

***, **,*denote significant at %10, %5 and %1level, respectively. For the countries only intercept critical values are %1: -3.94; %5:-3.29; %1: -2.94 and for the panel critical values are %1: -2.55; %5: -2.33; %10:-2.21. Δ denote the discrepancy of the variables.

Table 3indicates the outcome of the CADF unit root test. It has been determined that all variables are non-stationary and are stationary when the first difference is taken. Also CO_2variable becomes stationary at % 5significance level and all other variables arestationary at % 1significance level.

2.1.3. Homogeneity Test for Co-Integration Coefficients

The homogeneity test tests whether a change in one of the countries impresses the other countries equally. In this regard, this test is applied for countries with unusual economic structures. The homogeneity test provided by Swamy (1970), Pesaran and Yamagata (2008) tests the homogeneity of the slope coefficient in the co-integration equation.The following co-integration equation tests whether the slope coefficient $\beta_i$differs between cross- sections.

$$Y_{it=\alpha+}\beta_{iX_{it}}+\varepsilon_{it} \quad (7)$$

Hypotheses of the homogeneity test are;

H_0: $\beta_i = \beta$There is homogeneity in the slope coefficients.

H_1: $\beta_i \neq \beta$There is no homogeneity in the slope coefficients.

Two different test statistics were developed by Pesaran and Yamagata (2008) to test the hypotheses.

$$\text{Large Samples: } \hat{\Delta}=\sqrt{N}\left(\frac{N^{-1}\tilde{s}-k}{2k}\right)\sim X_k^2 \quad (8)$$

$$\text{Small Samples: } \hat{\Delta}_{adj}=\sqrt{N}\left(\frac{N^{-1}\tilde{s}-k}{v(T,k)}\right)\sim N(0,1) \quad (9)$$

According to equality below, k, S, N, and v(T,k) demonstrate the number of explanatory variables, Swamy test statistics, the cross-section number and standard error, respectively.

Table 4: Results of The Homogeneity Test

CO_{2t}= β_0+ $\beta_1 ENERGY_t$+$\beta_2 gdp_t$+$\beta_3 gdp_t^2$+$\beta_4 gdp_t^3$+ε_t	Test Statistics	Probability Value
$\tilde{\Delta}$	*4.896*	*0.000*
$\tilde{\Delta}_{adj}$	*5.046*	*0.000*

Since the probability values of the tests calculated in Table 4 are less than 0.05, $\mathrm{H}_0$was rejected. In the cointegration equation, it is decided that the constant term and slope coefficients are not homogeneous. In this case, cointegration interpretations for the countries in the panel are valid and can be trusted (Pesaran & Yamagata, 2008).

2.1.4. Panel Co-Integration Tests

Panel co-integration techniques are used to test the existence of long-run relationship between integrated variables with both time series dimension T and cross section dimension N. That is, the co-integration test is used to test the long-term relationship amongvariables (Pedroni, 2004; Westerlund, 2007; Westerlund, 2008). In this study, after testing the homogeneity and stationary of the series, the Westerlund co-integration test was decided in line with the information obtained.

The hypotheses of the test are as follows:

H_0: α_i= 0; Co-integration is not observed for all cross sections.

H_1: α_i< 0; Co-integration is observed for some sections.

Rejecting H_0 shows that there is a cointegration relationship among the variables for at least one of the cross-sections.

The error correction coefficient and standard error for the entire panel are calculated as follows:

$$P_t = \frac{\alpha_i}{se(\alpha_i)} \sim N(0, 1) \quad (10)$$

$$P_\alpha = T_\alpha \sim N(0, 1) \quad (11)$$

When H_o hypothesis is refused, it isapproved that there is indicates that there is co-integration relationfor all selected variables.

Table 5: Results of the Westerlund Panel Co-integration Test

Test	Statistical value	Probability value	Critical value
g_tau	4.025	0.000	0.133
g_alpha	-3.485	0.000	0.064
p_tau	-6.543	0.000	0.010
p_alpha	-7.410	0.000	0.000

Since the tests are statistically significant, theH_0hypothesis stating that there is noco-integration between the variables is rejected. In other words, the series move together in the long term and the model estimations to be made with the level values of these series will not involve artificial relationship problems.

2.1.5. Estimation of Long Term Co-integration Coefficients

To test co-integration among variables in a panel series, the CCE method provided by Pesaran(2006) was used. This method expresses steady and asymptotic normal dispersion results even when the time dimension is larger or smaller than the cross-section dimension. And it also remarks long-term values for each cross-section unit separately(Pesaran, 2006). Firstly, in this study, the effect of energy consumption and economic growth on carbon emission was analyzed. Then, the square and cubic forms of GDP were included to the model, respectively, and the analysis was performed. Model (1) can be written as follows:

$$CO_{2t} = \beta_0 + \beta_1 ENERGY_t + \beta_2 gdp_t + \varepsilon_t \quad (12)$$

Table 6 shows the long-term estimation results made with the CCE method.

Table 6: Estimation of Long-Term co-Integration Coefficients(Model 1)

Countries Variables	Energy	t-statistic	Gdp	t-statistic
Brazil	.9875049	0.000***	-.0646704	0.001***
China	.3912774	0.000***	.0230823	0.484
India	.8974151	0.000***	-.1080269	0.148
Indonesia	.6034145	0.000***	.1220745	0.028**
Malaysia	.6578203	0.000***	.1417912	0.092*
Mexico	.5504642	0.000***	.0400881	0.198
Philippines	1.284747	0.000***	-.2132056	0.024**
South Africa	-.2393207	0.441	.3866072	0.000***
Thailand	.8394327	0.000***	.1723425	0.000***
Turkey	.4724076	0.000***	.044994	0.160
Panel	.6796921	0.000***	.0484073	0.377

Note: The asterisks ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 6 reports that a %1 increase in energy consumption in the panel results in a .67969 increase in carbon emissions. It means that energy consumption has a positive effect on carbon emission at the %1level on significance. In addition, when the statistical values of GDP were examined; no significant results were obtained for the overall panel.

Model (2) can be written as follows:

$$CO_{2t} = \beta_0 + \beta_1 ENERGY_t + \beta_2 gdp_t + \beta_3 gdp_t^2 + \varepsilon_t \quad (13)$$

Table 7: Estimation of Long-Term Co-Integration Coefficients (Model 2)

Countries Variables	**Energy**	**t-statistic**	**gdp**	**t-statistic**	**gdp2**	**t-statistic**
Brazil	.9763994	0.000***	.0798797	0.710	-.0085611	0.503
China	.5591901	0.000***	.3936393	0.002***	-.0361061	0.000***
India	.5688379	0.000***	-1.772219	0.000***	.1287329	0.000***
Indonesia	.5667261	0.000***	1.026857	0.071*	-.0668798	0.105
Malaysia	.7187613	0.000***	1.399508	0.119	-.0970075	0.091*
Mexico	.2488128	0.003***	-.05017	0.912	.0074934	0.783
Philippines	.7591141	0.000***	-2.519659	0.006***	.1739148	0.004***
South Africa	.4285322	0.044**	.8161823	0.391	-.0433031	0.455
Thailand	.9250096	0.000***	1.315087	0.002***	-.0809219	0.004***
Turkey	.5406615	0.000***	-.0206174	0.955	.0041589	0.858
Panel	.6276829	0.000***	.2665158	0.518	-.0262067	0.296

Note: The asterisks ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

We have contained a squared term of economic growth (real GDP per capita) to test whether the relationshipbetween economic growth and carbon emissions (GDP and CO_2 emissions) is inverted -U shaped or U -shaped. As shown in the table, 1% ascends in energy consumption in the panel causes an increase of 0.627 in CO_2 emissions. The table presents that there is no relationship between carbon emissions and economic growth in the long term. Table 7 showsan inverted U-shape is observed for China and Thailand, and a U-shape for India and the Philippines, as well. However, the presence of the Kuznets Curve can't be mentioned for the overall panel.

Model (3) can be written as follows:

$$CO_{2t} = \beta_0 + \beta_1 ENERGY_t + \beta_2 gdp_t + \beta_3 gdp_t^2 + \beta_4 gdp_t^3 + \varepsilon_t \quad (14)$$

Table 8: Estimation of Long-Term Co-Integration Coefficients (Model 3)

Countries Variables	Energy	t-statistic	gdp	t-statistic	gdp2	t-statistic	gdp3	t-statistic
Brazil	.92989	0.00***	-5.26	0.002***	.6562	0.002***	-.027	0.002***
China	.63456	0.00***	1.36	0.335	-.1697	0.378	.0060	0.474
India	.52766	0.00***	4.15	0.171	-.7779	0.093*	.0456	0.050*
Indonesia	.83085	0.00***	9.73	0.000***	-1.375	0.000***	.0645	0.000***
Malaysia	.76015	0.00***	3.43	0.581	-.3697	0.651	.0120	0.735
Mexico	.29000	0.00***	6.12	0.390	-.7474	0.393	.0306	0.391
Philippines	.63668	0.00***	18.62	0.000***	-2.788	0.000***	.1371	0.000*
South Africa	.43645	0.04**	-28.52	0.092	3.567	0.087*	-.147	0.083*
Thailand	.53420	0.00***	-12.75	0.000***	1.800	0.000***	-.082	0.000***
Turkey	.5204	0.00***	-4.754	0.265	.6020	0.264	-.024	0.268
	.60656	0.00***	.498	0.903	-.1041	0.856	.0056	0.835

Note: The asterisks ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

In Table 8, the existence of the N-shaped EKC is analyzed. The N-shaped Environmental Kuznets Curve expresses that the novel inverted U-shaped EKC will not keep in the long-term. The N-shape initially indicates the same model as the inverted U-shape, but beyond a certain income level the relation between environmental pressure and income becomes positive again (De Bruyn et al., 1998). According to the results obtained, N-shaped Kuznets curve does not exist for the panel in general. But, there is an N-shaped EKCfor Indonesia and the Philippines when examined separately at the country dimension.

3. CONCLUSION AND POLICY IMPLICATIONS

In this study, the relationship between economic growth, energy consumption and carbon emission is analyzed both as an inverted-U-shaped and N-shaped EKC. Thus, using both square and cubic forms of per capita income data were analyzed under separate models. Ignoring cross-sectional dependency is to assume that macroeconomic shocks affect all countries in the panel in the same way. Therefore, for the effectiveness of the findings, second-generation panel unit root tests that take into account cross-sectional dependency should be applied. In the study, firstly, the cross-section dependency test provided by Pesaran was applied. Therefore, the rest of the analysis was shaped according to the results of this test. Economic growth and energy consumption are analyzed in three different models in the long term. In Model 1, it was found that energy consumption increases carbon emissions. Looking at Model 2, the EKC hypothesis cannot be confirmed for the entire panel. Finally, in model 3, the N-shaped EKC hypothesis could not be confirmed for the overall panel. One of the reasons why both EKC hypotheses could not be confirmed is thought to be due to the fact that although these countries are similar in terms of development level, their internal dynamics such as their location and the level of impact on the environment are quite different from each other.

As aresult, NICs, which account for the vast majority of the world's carbon emissions, should devote more budget to research and development to adopt environmentally friendly energy sources. Clean energy steps that will be taken now to reduce carbon emissions, in the long run, are very important both in the context of NICs and in the global context. NICs should also seek to create environmental awareness with human capital investments such as education investment. Also, increasing technological developments due to sensitivity to environmental and climate issues in the world have reduced the transportation and cost of renewable energy to a very reasonable level. So, these developing countries should reduce their fossil fuel consumption and pave the way for the use of alternative energy sources to fossil fuels.

NOTE:

[1]Emission Statistics: http://worldpopulationreview.com/countries/co2-emissions-by-country/

AUTHOR STATEMENT

This study has been prepared in accordance with scientific research and publication ethics.

Author Contributions

Contribution rate (100%)

Conflict of Interest

There is no conflict of interest for the authors or third parties arising from the study.

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