Alanya Akademik Bakış Dergisi
Yıl: 2022, C:6, S:3, s.3199-3214

Alanya Academic Review Journal
Year: 2022, Vol:6, No:3, p.3199-3214

The Myth of the Environmental Kuznets Curve: Second Generation Panel Approach for MIST Countries

(Research Article)

Çevresel Kuznets Eğrisi Efsanesi: MIST Ülkeleri için İkinci Nesil Panel Yaklaşımı

Doi: 10.29023/alanyaakademik.1018273

Sevginaz IŞIK
Department of Economics, Faculty of Economics and Administrative Sciences Bursa Uludağ University, Turkey
sevginaz@uludag.edu.tr
Orcid No: 0000-0002-4123-0860

How to cite this article: *Işık, S. (2022). The Myth of the Environmental Kuznets Curve: Second Generation Panel Approach for MIST Countries. Alanya Academic Review, Vol:6, No:3, p.3199-3214.*

Keywords:
EKC,
CO2 Emissions,
MIST Countries,
Second Generation Panel Approach,
PANICCA,
Durbin-Hausman Panel Cointegration,
AMG Estimator
Received: 02.11.2021
Accepted: 27.06.2022

ABSTRACT

The focus of the empirical analysis in this paper is to investigate the orthodox idea of "grow first, clean next" promoted by the Environmental Kuznets Curve hypothesis. In this respect, we examined the relation between CO2 emissions and economic growth for MIST countries for the period spanning from 1971 to 2016. With the help of second-generation panel data techniques, we employed the PANICCA unit root test, Durbin-Hausman Panel Cointegration test, and used the AMG estimator approach. The results strongly support a monotonously increasing relationship between CO2 emissions and economic growth. For the entire group and individually for Indonesia and Turkey, CO2 emissions per capita rise perilously as real GDP per capita increases.

1. INTRODUCTION

Since the beginning of the 1980s, globalization has gained momentum with the effect of neoliberalism. Not only the socio-economic consequences of this movement but also the environmental consequences have become irrevocable. To put it more clearly, without considering any natural boundaries, mainstream economics has promoted economic growth by either ignoring limits of nature or regarding nature as an external production source. In this context, especially in the last three decades, the focus of some economists inspired by the Kuznets Curve analysis of Simon Kuznets has become the effects of economic growth on the environment. Kuznets examined the relationship between economic growth and inequality in income distribution in 1955. As reported by the prominent paper, in the initial stages of growth where pre-industrial society moves to an industrial society, inequality in income distribution rises gradually; then, stabilizes for a while; and, after a certain level, the inequality declines (Kuznets, 1955: 19). In this respect, on a graph with growth on the horizontal axis and income distribution on the vertical axis, this relationship between these two variables takes the form of a geometrically inverse U.

Especially since the 1990s, some economists who have concerns about environmental degradation have been inspired by the Kuznets Curve and they have interpreted it differently. As stated in this reinterpretation, in the initial stages of industrialization, economic growth boosts environmental pollution until a turning point, and then environmental deterioration decreases as economic growth keeps going up. This reflects a bell-shaped relation between environmental degradation and economic growth. Since then, the nexus between environmental degradation and economic growth has been intensely theoretically and empirically examined. Therefore, a new field of study has emerged in the literature: Environmental Kuznets Curve (EKC) analysis. The concept and the hypothesis presented by Grossman and Krueger (1991), popularized by IBRD (1992) and flourished by significant contributors such as Shafik and Bandyopadhyay (1992), Panayotou (1993), Selden and Song (1994), Shafik (1994), Grossman and Krueger (1995), Holtz-Eakin and Selden (1995), Agras and Chapman (1999), Stern (2003), Stern (2004) and, Dinda (2004).

According to the seminal working paper conducted by Grossman and Krueger (1991), the effects of economic growth (via trade and foreign investment liberalization) on the environment can be identified as three distinct mechanisms: scale effect, composition effect and technique effect. In this context, the scale effect means that with the liberalization of trade, the more production is produced in an economy, the more pollution occurs. So, *ceteris paribus*, the scale effect inversely affects the environment. According to the composition effect, resources in countries shift to sectors that are heavily benefiting from abundant factors. The net impact of pollution depends on the expansion or contraction of pollution-intensive activities in the countries. Lastly, the technique effect represents the fact that with liberalization in foreign investment, cleaner technology transfers in countries increase, and with liberalization in trade, stricter enforcements of pollution abatement increase. So, the technique effect has a positive impact (Grossman and Krueger, 1991: 3-5).

It is also noteworthy to mention that the EKC hypothesis essentially asserts that economic growth ultimately does not harm the environment; on the contrary, growth positively affects the environment. In other words, the EKC hypothesis promises sustainable development for economies. For instance, Beckerman (1992) stated that economic growth is the safest long-term cure for solving environmental issues (Beckerman, 1992: 491). Similarly, as expressed by Dasgupta et al. (2002), an inverted U-shaped relation between environmental pollution and economic growth proposes "*grow first, then clean up*" (Dasgupta et al., 2002: 147).

Nevertheless, the findings in the literature review mentioned below are contradictory. Therefore, inconclusive results create a need for further investigation. Note that most of the empirical analysis in the EKC literature ignores the cross-section dependency (CD) across the countries. Such omission can cause doubtful results. Thus, in the case of the CD across units, thanks to the recent developments in panel data analysis, we can accurately test the nexus between carbon dioxide (CO_2) emissions and economic growth with appropriate econometric tools, and consequently, we can get more accurate results. For this reason, we take the CD across the countries into account and used the second-generation panel data approach and therefore, we got more reliable results. In this respect, with yearly data spanning from 1971 to 2016, we investigated the nexus between emissions and growth for Mexico, Indonesia, South Korea, and Turkey (MIST). A decade before, Jim O'Neill classified these countries as "growth markets". He stated that these economies are more than 1% of global GDP and also, they have the potential to grow more (Financial Times, 2011). For instance, in the last decade, their average GDP growth rates are 3%, 5,45%, 3,35%, and 6,35%, respectively (World Bank, 2019). Therefore, the impact of these rapidly growing economies on the environment is an issue to focus on. Moreover, there is a lack of empirical investigation of the existence of the EKC for MIST countries, in the literature. That's why we selected MIST countries.

Although the EKC hypothesis is extensively studied in the literature, the orthodox idea of "grow first, clean next" promoted by the hypothesis is still controversial, especially in developing countries. Therefore, whether the EKC hypothesis is the safest long-term way to solve environmental problems is still a question. Hence the fact that there is no consensus concerning the validity of the EKC in the literature, the omission of the CD across the selected countries, and the fact that the EKC for MIST countries has never been investigated before stay as gaps in the related literature. In order to fill that gap, we tested the EKC hypothesis by applying the second-generation panel data techniques for MIST countries.

We set the paper apart into four sections. The next section reviews the EKC literature, briefly. Then, after the data and methodology are elaborately presented, the results are reported in the third section. And the last one summarizes the whole paper.

2. LITERATURE REVIEW

Using cross-section analysis, Grossman and Krueger (1991) who first tested the hypothesis detected a bell-shaped relationship between urban air pollution (and smoke as indicators) and economic growth for different areas in different countries (42 countries for sulfur dioxide (SO_2) and 19 countries for smoke) in different years (1977, 1982 and 1988). They also reported a monotonically decreasing relation between suspended particles and growth for 29 countries (Grossman and Krueger, 1991).

Shafik and Bandyopadhyay (1992) explored the nexus using panel data analysis for 149 countries from 1960 to 1990. According to them, economies with rapid economic growth have a detrimental impact on natural resources at first; and then, there is an improvement in natural resources as growth gets higher. However, there is an exception here: there is no improvement in oxygen in rivers, municipal waste, and, remarkably, carbon emissions. Although the EKC hypothesis was reported as valid for particulates and SO_2, they accepted that there isn't any bell-shaped relation between carbon emissions and economic growth. According to their analysis, there aren't any improvements in carbon emissions per capita as income rises; conversely, it is continually worsening since the technological progress has not been emission-disincentive as expected (Shafik and Bandyopadhyay, 1992).

On the other hand, with the help of cross-section data, Panayotou (1993) who created the term "Environmental Kuznets Curve" in his working paper, investigated the EKC relation for selected countries over the 1980s. Using deforestation, SO_2, nitrogenous oxides, and solid particulates as dependent variables, he reached an inverted U-shaped relationship. So, the results of his analysis support the EKC hypothesis (Panayotou, 1993). Nonetheless, Shafik's (1994) results represented a monotonic positive relation between CO_2 emissions per capita and GDP per capita for the same data which he used in conducting a paper with Bandyopadhyay in 1992 (Shafik, 1994). By contrast, Selden and Song (1994) obtained an inverted U-shaped relation. They used different air pollution indicators such as particulates, SO_2, and oxides of nitrogen for 30 countries for incomplete data from 1973 to 1984 (Selden & Song, 1994).

Grossman and Krueger (1995), expanded their seminal paper in 1991 by also taking into account water pollution and found, again, an inverted U-shaped relation between various environmental pollution indicators and per capita GDP for different cities in different countries from 1979 to 1990 (Grossman and Krueger, 1995). Conversely, Agras and Chapman (1999) used the panel data method in their studies covering 34 countries including Mexico, Indonesia, South Korea, and Turkey for data from 1971 to 1989 and could not find any confirming results regarding the EKC relationship (Agras and Chapman, 1999).

The hypothesis hasn't been examined only in an empirical view. One of the crucial theoretical examinations belongs to Stern (2003; 2004). He gave a detailed brief on the developments in EKC literature until then and affirmed a monotonically rising relation between growth and emissions (Stern, 2003). Providing an effective critique of the EKC hypothesis, Stern (2004) concluded his paper by claiming that the empirical evidence of the validity of the EKC is weak (Stern, 2004). According to him, there is a monotonous relation between most of the environmental degradation indicators and income. Besides, Dinda (2004) also gave a core and an essential overview of the EKC literature, its theoretical background and presented methodological critique, till then (Dinda, 2004).

Taking manufacturing emissions as an air pollution indicator, Gallagher (2004) investigated the validity of the EKC for Mexico over the period between 1985 and 1999. He aimed to analyze the environmental performance of Mexico before and after the North American Free Trade Agreement (NAFTA). According to him, income in Mexico increased and the environment dramatically deteriorated after NAFTA. Still, he claimed that the EKC hypothesis is not wrong even though he couldn't prove the validity of the curve (Gallagher, 2004). On the other side, Azomahou et al. (2006) empirically investigated the nexus between CO_2 emissions per capita and real GDP per capita for data from 1960 to 1996 for 100 countries including Mexico, Indonesia, South Korea, and Turkey. Using panel techniques, they reported a monotonously increasing relation between these variables (Azomahou et al., 2006). Likewise, Song, Zheng, and Tong (2008) estimated the validity of the EKC curve for 29 provinces in China for the data spanning from 1985 to 2005 for different pollutants: waste gas, wastewater, and solid wastes. Their panel study results showed that an increase in economic growth leads to more drastic environmental problems. Besides, they gave attention to "irreversible damage". If a country reaches the point of irreversible environmental damage, there is no way to turn back (Song et al., 2008: 382).

One of the crucial empirical research was conducted by Akbostancı, Türüt-Aşık, and Tunç (2009). They applied two models with two different approaches: time series and panel data. According to the time series model which depends on yearly data from 1968 to 2003 for Turkey, there is a long-run monotonic relationship between CO_2 emissions per capita and GDP per capita. Nevertheless, in their panel data model for 58 provinces in Turkey in the same period, they reported an N-shaped EKC relation between income and air-polluting indicators (particulate matter and SO_2). Therefore, according to both two models, the inverted U-shaped EKC is not valid (Akbostancı et al., 2009). Similarly, Caviglia-Harris et al. (2009) took ecological footprint as an environmental degradation indicator in their analysis which includes 146 countries over the years 1961-2000. They didn't find any results in favour of the inverse U-shaped relation (Caviglia-Harris et al., 2009). By contrast, Apergis and Payne (2009) obtained supportive results concerning the existence of EKC. They used panel data methods with yearly data from 1971 to 2004 for six Central American countries and reached an inverted U-shaped relation between CO_2 emissions and real output in the long run (Apergis & Payne, 2009). However, by using time series, Choi et al. (2010) estimated the EKC hypothesis for South Korea, China, and Japan with yearly data from 1971 to 2006. They reached a U-shaped curve for South Korea; an N-shaped curve for China; and an inverted N-shaped curve for Japan. So, their results are ambiguous (Choi et al., 2010).

Fodha and Zaghdoud (2010) used time series and cointegration techniques for Tunisia with annual data from 1961 to 2004. They found a linear monotonically increasing relation between CO_2 emissions and GDP (Fodha and Zaghdoud, 2010). On the other hand, Saboori et al. (2012) tested the EKC hypothesis for Indonesia over the years 1971 to 2007. Using an autoregressive distributed lag approach, they got unsupportive results concerning the existence of the EKC such that they reported a U-shaped relationship between emissions and growth (Saboori et al., 2012). Apart from that for eight countries including Mexico and South Korea, Onafowora and Owoye (2014) examined the relationship between CO_2 emissions and income for the period between 1970 and 2010. They reported mixed results: an inverted N-shaped curve for South Korea; a weakly supported inverted U-shaped curve for Japan; and an N-shaped curve for the other six countries including Mexico (Onafowora and Owoye, 2014).

By conducting a panel data technique for five Southeast Asian countries from 1980 to 2008, Heidari et al. (2015) had overall consistent outcomes in favour of the existence of the EKC. However, they also found that CO_2 emissions go up as economic growth in Thailand, Indonesia, and the Philippines increases. So, they reported strong evidence for an inverted U-shaped relation overall although those three countries individually have monotonous relationships between growth and emissions (Heidari et al., 2015). Conversely, Sugiawan and Managi (2016) investigated the validity of the EKC for Indonesia by using time series. They took CO_2 emissions as a pollution indicator and used the original model by including energy production from renewable resources as another independent variable alongside income. For the period between 1971 and 2010, they reached an inverted U-shaped curve (Sugiawan and Managi, 2016).

One of the recent analyses has been done by Bakirtas and Cetin (2017). Over the years between 1982 and 2011, they estimated the EKC hypothesis for Mexico, Indonesia, South Korea, Turkey, and Australia (MIKTA). With the help of panel data, they found that the hypothesis is not valid for the MIKTA countries. They didn't report any individual performance (Bakirtas and Cetin, 2017). Likewise, by using the panel cointegration approach, Zoundi (2017) had unsupportive results concerning the validity of the EKC in his analysis which covers 25 African countries for data from 1980 to 2012 (Zoundi, 2017). On the other hand, Özokcu and Özdemir (2017) examined the nexus with the help of panel data for the period between 1980-2010. In their analysis, they selected two different groups of countries: 26 high-income OECD countries and 52 emerging market countries. According to their results, there is an inverted N-shaped relationship between CO_2 emissions and GDP for high-income countries and an N-shaped relationship between the same variables for emerging countries (Özokcu and Özdemir, 2017). In addition, Destek and Sarkodie (2019) used ecological footprint as an environmental degradation indicator to test the EKC hypothesis for 11 countries including Mexico, South Korea, and Turkey with yearly data from 1977 to 2013. In the context of the EKC, they found an inverted U-shaped curve for four countries including Mexico; and a U-shaped curve for five countries including South Korea and Turkey (Destek and Sarkodie, 2019).

To put it in a nutshell, there is not any consensus in the literature, but contradictory and conflicting results. The findings differ regarding the time period, countries, different pollution indicators, econometric methods, etc.

3. EMPIRICAL ANALYSIS: DATA, MODEL, METHODOLOGY, AND RESULTS

3.1. Data and Model

First, due to providing more degrees of freedom, we believed that panel data gives more efficient results and evidence. Therefore, we expanded the time series analysis of the standard form of EKC models used by Shafik and Bandyopadhyay (1992) with a time period. Moreover, in this paper, we used CO_2 emissions as the dependent variable since as being a primary greenhouse gas, CO_2 emissions are responsible for a wider scope of the impact caused by economic activities. For economic growth, we took real GDP per capita as in various studies in the literature. Thus, we tested the model as follows:

$$LCO_{2it} = \beta_0 + \beta_1 LGDP_{it} + \beta_2 LGDP_{it}^2 + \beta_3 LGDP_{it}^3 + \nu_{it} \quad (1)$$

where LCO_2 is the natural logarithm of CO_2 emissions tons per capita; LGDP is the natural logarithm of real GDP per capita in constant 2011 US dollars, ($LGDP^2$ and $LGDP^3$ are LGDP's quadratic and cubic forms, respectively); β_1, β_2, and β_3 represent the long-run elasticities of LCO_2 with respect to LGDP, $LGDP^2$, and $LGDP^3$, correspondingly; ν_{it} represents error terms. The dependent variable CO_2 per capita was derived from OECD (2019). Furthermore, real GDP and population (in persons, annually) were obtained from Fred (2019) and then, real GDP was transformed into real GDP per capita for all countries. And finally, to prevent the skewness and kurtosis of the data, per capita values of both CO_2 and real GDP were converted to the natural logarithm.

Due to data availability, we used annual data from 1971 to 2016 for four countries, namely, Mexico, Indonesia, South Korea, and Turkey. So, n=1, 2, ...4 and t=1, 2, …46. Note that as stated in the EKC hypothesis, for an inverted U-shaped curve, β_1 is anticipated to be higher than zero while β_2 is expected to be lower than zero (in the case of an N-shaped curve, β_3 is expected to be higher than zero).

3.2. Econometric Methodology

The omission of the econometric essentials such as CD and slope homogeneity alter the results as a matter of course and this is one reason why the findings in the literature are contradictory and different. Therefore, we first applied the preliminary tests.

3.2.1. Cross-Sectional Dependence Test

According to Baltagi (2005), the ignorance of the CD may cause deceptive results (Baltagi, 2005: 8). Therefore, before conducting a panel unit root test, to prevent biased results, the testing CD is crucial. In the panel data literature, we see four types of CD tests: (i) Breusch and Pagan's (1980) Lagrange multiplier (LM) test which is favourable when T is sufficiently larger than N; (ii) Pesaran's (2004) CD_{LM} test which is proposed for a case when N is sufficiently larger than T; (iii) Pesaran (2004) CD test which is developed for both N and T are large; and (iv) Pesaran, Ullah, and Yamagata's (2008) LM adjusted test which is also favourable so long as $T \geq N$. Since N is 4 and T is 46 in this paper, for our case, (i) and (iv) are best suitable, namely, LM and LM adjusted tests. These statistic tests can be summarized as follows:

- Breusch and Pagan's (1980) statistic uses the LM principle. Since this test is introduced more simply by Pesaran (2004: 4), we used Pesaran's expression (which is identical to Breusch and Pagan's statistic). Under the null hypothesis of cross-sectional independence, the test is expressed as:

$$LM = T\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}^{2} \qquad \sim \chi^{2}(N(N-1)/2) \tag{2}$$

where N, T and $\hat{\rho}^2_{ij}$ represent the number of cross-sections, time period, and *the sample estimate of the pair-wise correlation of the residuals*, respectively.

- Pesaran et al., (2008) developed a biased-adjusted LM statistic test which is consistent even though Pesaran's (2004) test is weak (Pesaran et al., 2008: 108). Under the null hypothesis of cross-sectional independence, the statistic is shown as:

$$LM_{adj} = \sqrt{\frac{2}{N(N-1)}}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\frac{(T-k)\hat{\rho}_{ij}^{2} - \mu_{Tij}}{\nu_{Tij}} \qquad \sim N(0,1) \tag{3}$$

To prevent biased results, our first step was to test CD.

3.2.2. Homogeneity Test

Testing slope homogeneity is the other crucial part of the preliminary analysis. In this paper, we used slope homogeneity tests established and presented by Pesaran and Yamagata (2008). The first one is the delta ($\tilde{\Delta}$) test is well-founded when (N, T) → ∞. Under the null hypothesis of homogeneity, $\tilde{\Delta}$ is represented as (Pesaran & Yamagata, 2008):

$$\tilde{\Delta} = \sqrt{N}\left(\frac{N^{-1}\tilde{S}-k}{\sqrt{2k}}\right) \qquad \sim N(0,1) \tag{4}$$

where $\tilde{S}$ represents the older and dispersion version of the slope test. The other slope homogeneity test is the delta adjusted ($\tilde{\Delta}_{adj}$) test. This test is suitable for numerous combinations of N and T. It is shown as:

$$\tilde{\Delta}_{adj} = \sqrt{\frac{N(T+1)}{T-k-1}}\left(\frac{N^{-1}\tilde{S}-k}{\sqrt{2k}}\right) \tag{5}$$

3.2.3. Unit root Analysis

Considering the existence of CD, we believed that continuing the analysis with first-generation panel unit root tests is a mistake. To reach unbiased results, with the help of some developments in panel data analysis, we applied the second-generation panel unit root test "PANICCA" which allows CD and slope homogeneity and also supports asymptotic distributions.

According to Reese and Westerlund (2016), to overcome the effects of CD, adopting the cross-section average (CA) approach is quite an advantageous way although it can be employed with non-standard asymptotic distributions. At that point, rather than taking the principal component analysis performed in the original PANIC approach of Bai and Ng (2004, 2010), they develop the PANIC approach based on CA which stands asymptotically: PANICCA (Reese and Westerlund, 2016). And their test statistics are defined as follows:

$$P_{a,0} = \frac{\sqrt{N}T(\hat{\rho}_0^+ - 1)}{\sqrt{2\hat{\phi}_\epsilon^4/\hat{\omega}_\epsilon^4}} \quad \sim N(0,1) \tag{6}$$

$$P_{a,1} = \frac{\sqrt{N}T(\hat{\rho}_1^+ - 1)}{\sqrt{36\,\hat{\sigma}_\epsilon^4\hat{\phi}_\epsilon^4/\widehat{5\omega}_\epsilon^8}}$$

$$P_{b,0} = \frac{\sqrt{N}T(\hat{\rho}_0^+ - 1)}{\sqrt{\hat{\phi}_\epsilon^4/[\hat{\omega}_\epsilon^2 N^{-1}T^{-2}\sum_{i=1}^{N}\left(\hat{e}_{i,-1}^0\right)'\hat{e}_{i,-1}^0]}} \quad \sim N(0,1) \tag{7}$$

$$P_{b,1} = \frac{\sqrt{N}T(\hat{\rho}_1^+ - 1)}{\sqrt{6\hat{\phi}_\epsilon^4\hat{\sigma}_\epsilon^4/[5\hat{\omega}_\epsilon^6\,N^{-1}T^{-2}\sum_{i=1}^{N}\left(\hat{e}_{i,-1}^1\right)'\hat{e}_{i,-1}^1]}}$$

$$PMSB_0 = \frac{\sqrt{N}[N^{-1}T^{-2}\sum_{i=1}^{N}\left(\hat{e}_{i,-1}^0\right)'\hat{e}_{i,-1}^0 - \hat{\omega}_\epsilon^2/2]}{\sqrt{\hat{\phi}_\epsilon^4/3}} \quad \sim N(0,1) \tag{8}$$

$$PMSB_1 = \frac{\sqrt{N}[N^{-1}T^{-2}\sum_{i=1}^{N}\left(\hat{e}_{i,-1}^1\right)'\hat{e}_{i,-1}^1 - \hat{\omega}_\epsilon^2/6]}{\sqrt{\hat{\phi}_\epsilon^4/45}}$$

where $\hat{\sigma}_\epsilon^2$ and $\hat{\omega}_\epsilon^2\hat{\phi}_\epsilon^4$ represent CA of $\hat{\sigma}_{\epsilon,i}^2$ and $\hat{\omega}_{\epsilon,i}^2\hat{\phi}_{\epsilon,i}^4$, respectively.

3.2.4. Cointegration

Most of the second-generation panel cointegration tests assume cross-sectional independence across the units. However, a notable feature of the Durbin-Hausman (DH) tests developed by Westerlund (2008) is that they allow the CD across the units. They depend on the DH principle. By assuming that common factors are stationary, the tests require only one condition: the dependent variable must be nonstationary. Assuming the null hypothesis states there is no cointegration for panel data, the DH test statistics are shown as (Westerlund, 2008):

$$DH_g = \sum_{i=1}^{n}\hat{S}_i\,(\tilde{\phi}_i - \hat{\phi}_i)^2\,\sum_{t=2}^{T}\hat{e}_{it-1}^2 \tag{9}$$

$$DH_p = \hat{S}_n\,(\tilde{\phi} - \hat{\phi})^2\sum_{i=1}^{n}\sum_{t=2}^{T}\hat{e}_{it-1}^2 \tag{10}$$

where DH_g and DH_p represent the group mean statistic and the panel statistic, correspondingly. DH_g is taken into account when a model is heterogeneous. On the contrary, DH_p is allowed for the existence of homogeneity in a model. Also, the null hypotheses of both tests are no cointegration.

3.2.5. Augmented Mean Group Estimator

To estimate the long-run parameters in the cointegration relation, we used the Augmented Mean Group (AMG) estimator established by Eberhardt and Bond (2009). The AMG estimator takes into consideration of CD and parameter heterogeneity. It is a suitable choice for the existence of CD in macro panels and the heterogeneity of the model (Eberhardt and Bond, 2009: 11).

3.3. Results

Table 1. Preliminary Tests Results

Test	LCO_2	LGDP	$LGDP^2$	$LGDP^3$	Model
LM	32.069*** [0.000]	38.737*** [0.000]	33.804*** [0.000]	34.604*** [0.000]	34.766*** [0.000]
LM_{adj}	55.618*** [0.000]	35.875*** [0.000]	38.425*** [0.000]	40.851*** [0.000]	6.438 *** [0.000]
$\widetilde{\Delta}$	-0.551 [0.709]	-1.261 [0.896]	-1.248 [0.894]	-1.175 [0.880]	11.904*** [0.000]
$\widetilde{\Delta}_{adj}$	-0.570 [0.716]	-1.304 [0.904]	-1.290 [0.902]	-1.215 [0.888]	12.458*** [0.000]

Note: *** represents the statistics are significant at the 1% level. Lag length is taken by 3, and constant and trend. P-values are in square brackets.
Source: Authors' estimations

According to the results illustrated in Table 1, CD across MIST countries significantly exists, which means they are cross-sectionally dependent. So, there is a strong dependence across MIST countries. In other words, if any environmental and/or economic decisions taken by, or any shocks experienced by one of the MIST countries affect others. Thus, we followed with second-generation panel unit root tests. Also, as reported in the same table, we failed to reject the null hypothesis of parameter homogeneity. So, parameters are homogenous. However, for the model, the slope homogeneity test rejects the null hypothesis at a 1% level of significance. Therefore, our model is heterogeneous. That information is required for deciding which test statistic has to be taken into account when investigating the existence of cointegration between variables.

Table 2. Second Generation Panel Unit Root Test: PANICCA Results

PANICCA	LCO_2	LGDP	$LGDP^2$	$LGDP^3$
Level				
Constant	Pa: 0.082 [0.533] Pb: 0.087 [0.535] PMSB: 0.241 [0.595]	Pa: 1.187 [0.882] Pb: 1.751 [0.960] PMSB: 2.629 [0.996]	Pa: 1.232 [0.891] Pb: 1.856 [0.968] PMSB: 2.843 [0.998]	Pa: 1.121 [0.869] Pb: 1.606 [0.946] PMSB: 2.353 [0.991]
Constant&Trend	Pa: 0.082 [0.533] Pb: 0.087 [0.535] PMSB: 0.241 [0.595]	Pa: 1.187 [0.882] Pb: 1.751 [0.960] PMSB: 2.629 [0.996]	Pa: 1.232 [0.891] Pb: 1.856 [0.968] PMSB: 2.843 [0.998]	Pa: 1.121 [0.869] Pb: 1.606 [0.946] PMSB: 2.353 [0.991]
First Difference				
Constant	Pa: -24.891***	Pa: -18.160***	Pa: -18.013***	Pa: -17.912***

	[0.000] Pb: -9.423*** [0.000] PMSB:-1.930** [0.027]	[0.000] Pb: -7.329*** [0.000] PMSB:-1.883** [0.030]	[0.000] Pb: -7.351*** [0.000] PMSB:-1.880** [0.030]	[0.000] Pb: -7.397*** [0.000] PMSB:-1.876** [0.030]
Constant&Trend	Pa: -24.891*** [0.000] Pb: -9.423*** [0.000] PMSB:-1.930** [0.027]	Pa: -18.160*** [0.000] Pb: -7.329*** [0.000] PMSB:-1.883** [0.030]	Pa: -18.013*** [0.000] Pb: -7.351*** [0.000] PMSB:-1.880** [0.030]	Pa: -17.912*** [0.000] Pb: -7.397*** [0.000] PMSB:-1.876** [0.030]

Note: *** and ** denote the statistics are significant at the 1% and 5% levels of significance, correspondingly. The maximum lag length was preferred to be 3. We chose the Schwarz Information Criteria. P-values are in square brackets.
Source: Authors' estimations

As can be seen in Table 2, our variables LCO_2, LGDP, $LGDP^2$, and $LGDP^3$ are nonstationary in their level (especially when it is included intercept and trend in the test equation). Moreover, all variables are stationary at their first difference, i.e., they are integrated at their first order: I~ (1). So, we can proceed to estimate a cointegration relation between variables. Since the dependent variable is nonstationary at its level and there is the CD across units, the results provide the necessary condition to test the second-generation panel cointegration test: the DH Panel Cointegration Test.

Table 3. DH Panel Cointegration Test Results

Model	Panel DH Cointegration Test
$LCO_{2it} = \beta_0 + \beta_1 LGDP_{it} + \beta_2 LGDP^2_{it} + \beta_3 LGDP^3_{it} + \nu_{it}$	DH-group: -1.652** [0,049] DH-panel: -1.593 [0.056]

Note: ** shows that statistics are significant at the 5% level of significance. Bayesian information criterion (BIC) was preferred. P-values are in square brackets.
Source: Authors' estimations

Since our models are heterogeneous, DH_g test results should be taken into consideration. Therefore, according to the results reported in Table 4, for the model without trend, variables are cointegrated. This means we detected a cointegration relation at the 5% level of significance. As a result, there is a long-run relationship between CO_2 emissions and economic growth as expected.

Table 4. Long-Term Parameter Estimations: The AMG Estimator Results

	Panel	**Mexico**	**Indonesia**	**South Korea**	**Turkey**
LGDP	11.051 [0.071]*	1.919 [0.983]	21.202 [0.001]***	1.684 [0.191]	19.423 [0.053]*
LGP2	2.484 [0.028]**	1.384 [0.947]	3.768 [0.002]***	0.286 [0.318]	4.464 [0.054]*
LGDP3	0.202 [0.013]**	0.193 [0.903]	0.226 [0.002]***	0.022 [0.272]	0.352 [0.047]**

_cons	18.146 [0.098]*	-0.956 [0.994]	39.058 [0.001]***	5.108 [0.006]***	29.623 [0.040]**
Wald Chi2	14.29 [0.0025]***				

Note: ***, ** and * denote the statistics are significant at the 1%, 5% and 10% levels of significance, correspondingly. Square brackets denote the P-values.
Source: Authors' estimations

According to the panel the AMG estimator results demonstrated in Table 5, all the coefficients are significant and positive. Also, the panel as a whole is significant at a 1% level of significance. Since all variables were converted to the natural logarithm, the coefficients can be taken as the long-run elasticities. As a result, for MIST countries, a 1% increase in real GDP per capita (in squared real GDP per capita and quadratic real GDP per capita) leads to approximately 11% (2.48% and 0.2%, respectively) increase in CO_2 emissions. On the other hand, individually, test results are also significant and positive for both Indonesia and Turkey. For Indonesia, a 1% increase in real GDP per capita (in squared real GDP per capita and quadratic real GDP per capita) causes approximately 21% (3.76% and 0.22%, respectively) increase in CO_2 emissions. Similarly, for Turkey, a 1% increase in real GDP per capita (in squared real GDP per capita and quadratic real GDP per capita) leads to approximately 19% (4.46% and 0.35%, respectively) increase in CO_2 emissions. As a result, an increase in economic growth in Indonesia and Turkey causes more emissions. Note that the EKC hypothesis expects $\beta_1 <0$, $\beta_2>0$, and $\beta_3=0$ meaning an inverted U-shaped curve. However, we found a monotonically positive relationship between CO_2 emission and economic growth for MIST countries as a whole panel group and for individually, Indonesia, and Turkey. So the results mean that CO_2 emission per capita worsens perilously as real GDP per capita increases for these countries.

Therefore, the results presented here directly contradict: (i) the validity of the inverted U-shaped EKC supported by Apergis and Payne (2009) (for six Central American countries), Heidari et al. (2015) (for Indonesia), Sugiawan and Managi (2016) (for Indonesia), Destek and Sarkodie (2019) (for 11 countries including Mexico, South Korea, and Turkey); (ii) the validity of the U-shaped EKC detected by Choi et al. (2010) (for South Korea) and Saboori et al. (2012) (for Indonesia); (iii) the validity of the N-shaped EKC reached by Onafowora and Owoye (2014) (for Mexico), Özokçu and Özdemir (2017) (for 52 emerging countries); (iv) the validity of the inverted N-shaped EKC found by Onafowora and Owoye (2014) (for South Korea), Özokçu and Özdemir (2017) (for 26 high-income countries). In addition, our analysis also disproves the analysis done by Gallagher (2004) (for Mexico) who could neither prove nor deny the validity of the inverted U-shaped EKC. On the contrary, our results significantly confirm the monotonous relationship between CO_2 emissions and economic growth supported also by Shafik and Bandyopadhyay (1992) (for 149 countries), Shafik (1994) (for 149 countries), Azomahou et al. (2006) (for 100 countries including Mexico, Indonesia, South Korea, and Turkey), Akbostancı et al. (2009) (for Turkey) and Fodha and Zaghdoud (2010) (for Tunisia).

4. CONCLUSION

The fact that MIST countries have rapidly growing economies draws attention to investigate their effects on the environment. Therefore, by using data from 1971 to 2016, we examined the link between CO_2 emissions whose impact range is a global scale and real GDP per capita for MIST countries. Note that our data is cross-sectionally dependent. Although most of the studies ignored the CD across the countries, we took the CD into consideration. Therefore, we continued the analysis accordingly. The core contribution of this paper is taking the CD into account. Then, we used the second-generation unit root test, PANICCA, and according to the results, our variables are first integrated of order. Then, we applied the second-generation DH panel cointegration test. After detecting a long-term relation, we estimated the long-term parameters by using the AMG estimator approach. We found a monotonous relationship between CO_2 and income for MIST countries, for the whole group and for Indonesia and Turkey, individually which is not surprising since Indonesia and Turkey have the highest growth rates in the group. According to the panel results, a 1% increase in real GDP per capita leads to an approximately 11% increase in CO_2 emissions. In addition, according to the unit's results, for Indonesia, a 1% increase in real GDP per capita causes an approximately 21% increase in CO_2 emissions; and for Turkey, a 1% increase in real GDP per capita also leads to an approximately 19% increase in CO_2 emissions. Thus, for MIST countries, economic growth cannot be the safest long-term way to solve environmental problems.

Apparently, in MIST countries, the scale effect is dominant since the monotonous relation means that the more economic activities, the more economic growth, and the more increase in CO_2 emissions. In addition to that, there might be no radical change and/or environmentally friendly developments in technology (if any, it is not sufficient). In other words, the technique effect in these countries is insufficient. It is clear that economies grow with environmental problems, especially in Indonesia and Turkey. These countries focus on evidently economic growth instead of environmental quality. Since it is obvious that environmental quality is far from being a priority concern for these countries. Therefore, "grow first, clean next" does not work for these countries. It is also noteworthy that there is a risk of reaching the point of irreversible damage as Song et al. (2008) claimed for MIST countries. This leads us to suggest that the governments of MIST countries should change their actions and attitudes concerning a more environmentally friendly point of view. Moreover, they should make radical changes in technologies by concentrating on building renewable energy sources if they want to have sustainable economic growth; otherwise, they will suffer from crucial environmental problems.

To sum up, although the EKC hypothesis substantially and unremorsefully asserts that economic growth can reduce environmental pollution, our results showed that CO_2 emission per capita worsens perilously as real GDP per capita increases. This is perilous since the increase in CO_2 emissions not only has adverse effects locally but also incites global climate change. Therefore, especially for rapidly growing economies like MIST countries, the findings here suggest that economic growth cannot be a solution for environmental quality. On the contrary, in the light of the empirical findings obtained in this study, it can be asserted that economic growth itself is the main reason for environmental degradation. If the policymakers in MIST countries are willing to have a sustainable environment and protect environmental quality in the long term, they should consider the negative effects of economic growth on the environment and make policies accordingly. Otherwise, irreversible dimensions may be reached due to increased emissions and reduced environmental quality. For that reason, the results raise the importance of the need for environmental-friendly policies before the irreversible damage point is reached. Despite the planet facing global climate change today, the consequences of continuing to grow can be frightening. In a nutshell, our analysis refutes the orthodox idea of "grow first, clean next" promoted by the EKC hypothesis. So, the EKC hypothesis stays as a myth for MIST countries.

REFERENCES

AGRAS, J., & CHAPMAN, D. (1999). "A Dynamic Approach to the Environmental Kuznets Curve Hypothesis''. Ecological Economics, 28(2), 267–277. https://doi.org/10.1016/S0921-8009(98)00040-8

AKBOSTANCI, E., TÜRÜT-AŞIK, S., & TUNÇ, G. I. (2009). "The Relationship Between Income and Environment in Turkey: Is There An Environmental Kuznets Curve? ''. Energy Policy, 37(3), 861–867. https://doi.org/10.1016/j.enpol.2008.09.088

APERGIS, N., & PAYNE, J. E. (2009). "CO2 Emissions, Energy Usage, and Output in Central America''. Energy Policy, 37(8), 3282–3286. https://doi.org/10.1016/j.enpol.2009.03.048

AZOMAHOU, T., LAISNEY, F., & NGUYEN VAN, P. (2006). "Economic Development and CO2 Emissions: A Nonparametric Panel Approach''. Journal of Public Economics, 90(6–7), 1347–1363. https://doi.org/10.1016/j.jpubeco.2005.09.005

BAI, J., & NG, S. (2004). "A Panic Attack on Unit Roots and Cointegration''. Econometrica, 72(4), 1127–1177. https://doi.org/10.1111/j.1468-0262.2004.00528.x

BAI, J., & NG, S. (2010). "Instrumental Variable Estimation in a Data Rich Environment''. Econometric Theory, 26, 1577-1606. https://doi.org/10.1017/S0266466609990727

BAKIRTAS, I., & CETIN, M. A. (2017). "Revisiting the Environmental Kuznets Curve and Pollution Haven Hypotheses: MIKTA Sample''. Environmental Science and Pollution Research, 24(22), 18273–18283. https://doi.org/10.1007/s11356-017-9462-y

BALTAGI, B. H. (2005). Econometric Analysis of Panel Data (Third Ed.). John Wiley and Sons, Ltd.

BECKERMAN, W. (1992). "Economic Growth and the Environment: Whose Growth? Whose Environment? ''. World Development, 20(4), 481–496. https://doi.org/10.1016/0305-750X(92)90038-W

BREUSCH, T. S., & PAGAN, A. R. (1980). "The Lagrange Multiplier Test and its Applications to Model Specification in Econometrics''. Review of Economic Studies, 47(1), 239–253.

CAVIGLIA-HARRIS, J. L., CHAMBERS, D., & KAHN, J. R. (2009). "Taking the "U " out of Kuznets. A Comprehensive Analysis of the EKC and Environmental Degradation''. Ecological Economics, 68(4), 1149–1159. https://doi.org/10.1016/j.ecolecon.2008.08.006

CHOI, E., HESHMATI, A., & CHO, Y. (2010). "An Empirical Study of the Relationships between CO2 Emissions, Economic Growth and Openness''. IZA Discussion Paper Series (Issue 5304).

DASGUPTA, S., LAPLANTE, B., WANG, H., & WHEELER, D. (2002). “Confronting the Environmental Kuznets Curve’’. The Journal of Economic Perspectives, 16(1), 147–168. https://doi.org/10.2307/2696580

DESTEK, M. A., & SARKODIE, S. A. (2019). “Investigation of Environmental Kuznets Curve for Ecological Footprint: The Role of Energy and Financial Development’’. Science of the Total Environment, 650, 2483–2489. https://doi.org/10.1016/j.scitotenv.2018.10.017

DıNDA, S. (2004). “Environmental Kuznets Curve Hypothesis: A Survey’’. Ecological Economics, 49(4), 431–455. https://doi.org/10.1016/j.ecolecon.2004.02.011

EBERHARDT, M., & BOND, S. (2009). “Cross-section Dependence in Nonstationary Panel Models: A Novel Estimator’’. Munich Personal RePEc Archive, 17692.

FINANCIAL TIMES (2011), “Bric Creator Adds Newcomers to List’’. By Jennifer Hughes in, January 17 2011. Accessed on 17th December, 2019 through the link https://www.ft.com/content/f717c8e8-21be-11e0-9e3b-00144feab49a

FODHA, M., & ZAGHDOUD, O. (2010). “Economic Growth and Pollutant Emissions in Tunisia: An Empirical Analysis of the Environmental Kuznets Curve’’. Energy Policy, 38(2), 1150–1156. https://doi.org/10.1016/j.enpol.2009.11.002

FRED (2019). Federal Reserve Bank of St. Louis Economic Data. Accessed on 12th September, 2019 through the link https://fred.stlouisfed.org/

GALLAGHER, K. P. (2004). Free Trade and the Environment: Mexico, NAFTA, and Beyond. Stanford University Press. California.

GROSSMAN, G. M., & KRUEGER, A. B. (1991). “Environmental Impacts of a North American Free Trade Agreement’’. National Bureau of Economic Research Working Paper Series, No. 3914(3914), 1–57. https://doi.org/10.3386/w3914

GROSSMAN, G. M., & KRUEGER, A. B. (1995). “Economic Growth and the Environment’’. The Quarterly Journal of Economics, 110(2), 353–377.

HEIDARI, H., TURAN KATIRCIOĞLU, S., & SAEIDPOUR, L. (2015). “Economic Growth, CO2 Emissions, and Energy Consumption in the Five ASEAN Countries’’. International Journal of Electrical Power and Energy Systems, 64, 785–791. https://doi.org/10.1016/j.ijepes.2014.07.081

IBRD. (1992). World Development Report 1992: Development and the Environment. Oxford University Press.

KUZNETS, S. (1955). “Economic Growth and Income Inequality’’. The American Economic Reviewconomic, 45(1), 1–28.

OECD (2019). OECD Data. Accessed on 12th September, 2019 through the link https://data.oecd.org/air/air-and-ghg-emissions.htm

ONAFOWORA, O. A., & OWOYE, O. (2014). “Bounds Testing Approach to Analysis of the Environment Kuznets Curve Hypothesis’’. Energy Economics, 44, 47–62. https://doi.org/10.1016/j.eneco.2014.03.025

ÖZOKCU, S., & ÖZDEMİR, Ö. (2017). “Economic Growth, Energy, and Environmental Kuznets Curve’’. Renewable and Sustainable Energy Reviews, 72(November 2016), 639–647. https://doi.org/10.1016/j.rser.2017.01.059

PANAYOTOU, T. (1993). “Empirical Tests and Policy Analysis of Environmental Degradation at Different Stages of Economic Development’’. ILO Working Papers (Issue WP 238).

PANAYOTOU, T. (1997). “Demystifying the Environmental Kuznets Curve: Turning A Black Box into a Policy Tool’’. Environment and Development Economics, 2(4), 465–484. https://doi.org/10.1017/S1355770X97000259

PESARAN, M. H. (2004). “General Diagnostic Tests for Cross Section Dependence in Panels’’. In Cambridge Working Papers in Economics (Issue 0435). https://doi.org/10.17863/CAM.5113

PESARAN, M. H., ULLAH, A., & YAMAGATA, T. (2008). “A Bias-adjusted LM Test of Error Cross-Section Independence’’. Econometrics Journal, 11, 105–127. https://doi.org/10.1111/j.1368-423X.2007.00227.x

PESARAN, M.H., & YAMAGATA, T. (2008). “Testing Slope Homogeneity in Large Panels’’. Journal of Econometrics, 142(1), 50–93. https://doi.org/10.1016/j.jeconom.2007.05.010

REESE, S., & WESTERLUND, J. (2016). “Panicca: Panic on Cross-Section Averages’’. Journal of Applied Econometrics, 31, 961–981. https://doi.org/10.1002/jae

SABOORI, B., SULAIMAN, J. BIN, & MOHD, S. (2012). “An Empirical Analysis of the Environmental Kuznets Curve for CO2 Emissions in Indonesia: The Role of Energy Consumption and Foreign Trade’’. International Journal of Economics and Finance, 4(2), 243–251. https://doi.org/10.5539/ijef.v4n2p243

SELDEN, T. M., & SONG, D. (1994). “Environmental Quality and Development: Is There a Kuznets Curve for Air Pollution Emissions? ’’. Journal of Environmental Economics and Management, 27, 147–162.

SHAFIK, N. (1994). “Economic Development and Environmental Quality: An Econometric Analysis’’. Oxford Economic Papers, 46, 757–773. https://doi.org/10.1400/61750

SHAFIK, N., & BANDYOPADHYAY, S. (1992). “Economic Growth and Environmental Quality: Time Series and Cross-Country Evidence’’. In Background Paper for World Development Report 1992: Vol. WPS 904.

SONG, T., ZHENG, T., & TONG, L. (2008). “An Empirical Test of the Environmental Kuznets Curve in China: A Panel Cointegration Approach’’. China Economic Review, 19(3), 381–392. https://doi.org/10.1016/j.chieco.2007.10.001

STERN, D. I. (2003). “The Environmental Kuznets Curve’’. In International Society for Ecological Economics- Internet Encyclopaedia of Ecological Economics (Issue June). https://doi.org/10.1080/1350485042000207216

STERN, D. I. (2004). “The Rise and Fall of the Environmental Kuznets Curve’’. World Development, 32(8), 1419–1439. https://doi.org/10.1016/j.worlddev.2004.03.004

SUGIAWAN, Y., & MANAGI, S. (2016). "The Environmental Kuznets Curve in Indonesia: Exploring the Potential of Renewable Energy''. Energy Policy, 98, 187–198. https://doi.org/10.1016/j.enpol.2016.08.029

WESTERLUND, J. (2008). "Panel Cointegration Tests for the Fisher Effect''. Journal of Applied Econometrics, 23, 193–233. https://doi.org/10.1002/jae

WORLD BANK (2019). World Development Indicators. Accessed on 10th September, 2019 through the link https://databank.worldbank.org/reports.aspx?source=wdi-database-archives-%28beta%29#

ZOUNDI, Z. (2017). "CO2 Emissions, Renewable Energy and the Environmental Kuznets Curve, A Panel Cointegration Approach''. Renewable and Sustainable Energy Reviews, 72(July 2016), 1067–1075. https://doi.org/10.1016/j.rser.2016.10.018