



Beyond the environmental Kuznets curve: Do combined impacts of air transport and rail transport matter for environmental sustainability amidst energy use in E7 economies?

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Abstract

This study is motivated by the United Nations Sustainable Development Goals (UN-SDG-7,8,11,12 and 13) on the need for clean and responsible energy consumption in view of anticipated actions for environmental sustainability. The world has been plagued with various consequences of environmental degradation including the attendant risks of climate change which has been exacerbated by rising greenhouse gas (GHGs) emissions over the years. To this end, we explore the combined effect of rail, air transportation, and urbanization in an EKC framework for the case of the E7 economies between 1995 and 2016. This study distinguishes itself from the extant ones by extending the EKC framework to explore the nexus between air transport, rail transport, urbanization, and the environment. The empirical evidence obtained from the study is based on second-generation panel econometric methods that are robust to heterogeneity and cross-sectional issues. Firstly, the findings lend support to the EKC phenomenon for E7 economies, thereby, implying that emphasis is placed on higher-income status in the bloc relative to environmental sustainability. Secondly, conventional energy from fossil fuel and air transport significantly dampen environmental quality among the E7 economies. Thirdly, rail transport and urban population, on the contrary, strongly aid the improvement of environmental quality among the E7 countries thus underscoring the significance of green urban mass (rail) transportation to the environmental sustainability agenda. Hence, in view of the economic growth trajectory among the E7 economies, useful policy blueprints were highlighted in the concluding section of the study.

Keywords Energy consumption · Decarbonization · Environmental sustainability · Panel econometrics · E7 economies

JEL Classification C32 · Q 40 · Q43

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1 Introduction

Various forms of transportation including land, water, and air are essential aspects of every country's economy. However, economic enhancement from the transportation industry has its own challenges as there are environmental consequences of the attendant greenhouse gas (GHGs) emissions from the transport sector. Transportation activities are estimated to be accounting for 14% of the overall pollutions (Air Transport Action Group, 2019). As a breakdown, road transport is the largest source of pollution from the transport sector, while the second-largest contributor is the aviation sector which contributes around 2 to 4% of the overall pollution within the anthropogenic emissions (Air Transport Action Group, 2019).

Emissions from the transport sector are generally harmful and those from the aviation sector are seen as much more harmful compared to the other transport operations since they directly distort the ozone structure at high temperatures and exacerbate the accumulation of greenhouse gases in the surface setting. The Intergovernmental Panel on Climate Change reported that the aviation sector was responsible for about 3.5% of the global warming from anthropogenic origins in the early 1990s and this harm has aggravated in the last couple of decades given the massive rise in global air transport demand (Bows et al., 2009; IPCC, 1999; Sampigethaya & Poovendran, 2013). While one-second of the pollutions is discharged in the close-surface area, the next one-second could be beyond 6000 m higher (Apergis & Payne, 2012). If there are around 986 kg of carbon dioxide emissions per passenger on a round-trip flight from London to New York, then this assessment is more remarkable than a yearly average per capita CO₂ pollution of fifty-six nations. Hence, Kommenda (2019) was of the view that the airline business raises the surface and ambient pollution together, which in turn raises environmental pollution. Furthermore, part of the leading industries that needed more consideration on the subject matter of environmental sustainability as highlighted in the 1997 Kyoto Protocol was the transport industry, and the aim was to reduce global pollution by 5.2% in 2012 from 1990 levels (Chapman, 2007).

Aside from the atmospheric challenges, pollution associated with transportation can also be accompanied by other important economic threats since the developments in the transport sector can constitute a significant component of the growth trajectory in an economy. Therefore, different stages of economic growth may be characterized by diverse degrees of environmental pollution and this calls for different forms of environmental protection legislation depending on the observed nexus between the pollution level and associated variables like transport, energy consumption, and urbanization among other variables. Core to the economic growth-pollution nexus is the Environmental Kuznets Curve (EKC) which hypothesizes that ecological weight rises and subsequently decreases to a particular stage of economic development (Kuznets, 1955; Panayotou, 1997).

A number of studies have confirmed the endorsement of the EKC concept, that is, an inverted U-shape nexus between pollutant and economic development (Sugiawan and Managi, 2016; Almulali et al., 2015; Bekun et al., 2021; Zaman et al., 2016; Onifade et al., 2021a; Gyamfi et al., 2021). The EKC concept has been identified as a valuable theoretical instrument for solving ecological concerns triggered by pollution (Alola et al., 2021a, 2021b; Sarkodie & Strezov, 2019a, 2019b). The reduction in environmental problems triggered by transport pollution would result in a rise in the amount of income to a stage, whereby the burden on the environment is starting to decrease. Energy intake will result in a rise in pollution, whereas air and rail carriage systems contribute greatly to energy emissions.

Therefore, to ensure the sustainability of transport operations, the widespread use of electricity-powered railways has traditionally been considered an eco-friendly mode of transport. A two-way causality linkage between pollution and transport has been identified by Abdallah et al. (2013) showing that transport granger causes CO₂ emission and vice versa. Results from other research carried out on the transport-emission association, however, continue to be indecisive. Moreover, we can identify more contrary opinions that stress the airline industry's economic advantages. As such, a proper evaluation of the impacts of transport emissions as the key environmental concern of the transport industry is a major focus in this study given that minimal examination has been conducted in this regard, especially within the framework of the environmental Kuznets curve (EKC).

Hence, this analysis aims to examine the significance of the airline and railway industries to address environmental pollution among the emerging seven (E7) countries including China, India, Brazil, Mexico, Russia, Indonesia, and Turkey. Currently, only a few studies have distinctly explored the transport-emission connection in the literature to specifically ascertain the EKC. In addition, to the best knowledge of the authors, no research has examined the combined impacts of the airlines and the railway industry on environmental pollution for the specific case of the E7 economy in the sense of the EKC hypothesis. Meanwhile, such a study is expected to help in decision-making as the findings from this analysis could be crucial to safeguarding the ecological sustainability of the member states via eco-friendly transport machinery and infrastructures while maintaining a desirable economic growth path.

2 Literature review

Environmental pollution and economic growth nexus have been widely studied by different scholars since the early study of Grossman and Krueger (1991). Grossman and Krueger (1991) set out to uncover the trend of ecological deterioration amidst complex growth direction among 42 countries. Therefore, to empirically evaluate the relation, a cubic model was used, and an N-shaped connection regarding ecological pollutants and economic progress was reported. Subsequently, the environmental-economic progress connection has been established in numerous models using multiple technical approaches while exploring the validity of the EKC vis-à-vis energy-related or macro-economic factors as shown in Table 1.

Although economic progress is a focal theme that shape policy formations and implementations among several countries, there have been different reports on the relationship regarding the use of energy and economic growth from studies in the empirical literature (Adedoyin et al., 2020; Gyamfi et al., 2020a, 2020b; Onifade et al., 2021b). From most of the studies, three (3) different observations can be drawn out from the connection regarding energy, pollution, and growth, namely feedback causality, one-way causality, and no causal connections. A feedback causal association regarding pollutants and income level was found in the study of Pao and Tsai (2011), while the analyses by Solarin (2014) established a uni-directional correlation between income levels and environmental pollution as seen in the level of CO₂ emission. A uni-directional connection from economic development to clean energy was verified in the study for the short-term using disaggregated energy, whereas a bi-directional connection was confirmed in the long term. On the other hand, Apergis and Payne (2012) confirmed a bi-directional association between non-renewable energy use and economic progress in both the short and long term. Also, Ozcan et al.

Table 1 Relations among ecological pollution, energy use, and economic indicators within the EKC framework

Author(s)	Sample-period	method	Energy-macroeconomic variables	EKC
Erdogan et al., (2020)	Top 10 air and rail transport 1995–2014	Robust panel estimator	CO ₂ GDP	Valid
Sarkodie and Strezov (2019a, 2019b)	5 Countries, 1982–2016	Driscoll-Kraay Method	Foreign Direct (+) Energy consumption (+)	Valid
Wong et al., (2018)	Jan, Asia, Korea	DID	POP GDP	valid
Ulucaek and Bilgili (2018)	Low-, Middle-, and High-Income Countries, 1961–2013	CUP-FM, CUP-BC	TR (M) Human Capital (M) Bio-capacity (M)	Valid
Aslan et al. (2018)	USA, 1966–2013	Bootstrap Rolling Window Approach	–	Valid
Pata (2018)	Turkey, 1971–2014	ARDL	FD (+) UR (+) Import (+) Export (–) Industrialization (+) CC (+) Non carbohydrate energy (–) EC (+)	Valid
Destek et al. (2018)	EU countries (1980)–(2013)	CCE-Mean Group		
Nrec (+) Nre (*) Tr (*)	Invalid			
Acaravci and Akalin (2017)	Developed and Developing Countries, 1980–2010	CCE	TR(M)	Valid
Dogan and Turkekul (2016)	USA, 1960–2010	ARDL	EC (+) FD (–) UR (+) Tr (+)	M(valid)
Ertugrul et al. (2016)	Developing Countries, 1971–2011	ARDL	TR (M) EC (M)	Valid

Table 1 (continued)

Author(s)	Sample-period	method	Energy-macroeconomic variables	EKC
Shahbaz et al. (2016)	19 African Countries, 1971–2012	ARDL	Energy Intensity (M) Globalization (M)	Valid
Shahbaz et al. (2015)	12 Africa Countries, 1980–2012	PDA	REC (M) TR (M) UR (M)	valid
Jebli et al. (2016)	25 OECD Countries, 1980–2010	FMOLS, DOLS	Energy Intensity (M)	valid
Al-Mulali et al. (2016)	7 Regions, 1980, 2010	DOLS	Globalization (M)	Valid
Apergis and Ozturk (2015)	14 Asian Countries, 1990–2011	GMM, FMOLS, DOLS	TR (+) Population Density (–) Land (+) Industry Shares in GDP (+) Institutions (M)	Valid
Shahbaz et al. (2015)	12 Africa Countries, 1980–2012	PDA	Energy Intensity (+)	Valid
Panayotou (1997)	30 developed and developing Countries	FE, RE	Population value	Valid
Selden and Song (1994)	30 Countries	POLS, FE, RE	Population Density (+)	valid
Shafik and Bandyopadhyay (1992)	149 Countries, 1960–1990	PRE	Population Density (–)	Invalid

M: Mixed Results, REC: Renewable Energy Consumption, NREC: Non-Renewable Energy Consumption, TR: Trade Openness, UR: Urbanization, FD: Financial Development, EC: Energy Consumption; *: No Statistically Significant Effect, CC: Coal Consumption, POLS: Pooled OLS, FE: Fixed Effects, RE: Random Effects, GMM: Generalized Method of Moment, FMOLS: Fully Modified Ordinary Least Squares, DOLS: Dynamic OLS, PRE: Panel Regression Analysis, PDA: Panel Data Analysis, CCE: Common Correlated Effect Estimator

(2019) noted that adding renewables dispersion had an extenuating impact on ecological deprivation, whereas traditional energy bases stimulate CO₂ emission thereby supporting the earlier point by Cowan et al. (2014) that the diversification of energy combination with clean energy has beneficial effects on economic growth.

2.1 Transportation, urbanization, and emission nexus

The ecological effects of commuting cannot be overemphasized since the transport industry is one of the world's largest energy users that consumes a significant proportion of conventional energy. It has been observed that both air and rail transportation have a critical association with the demand for energy (Rashid et al., 2018), and the end result of the rising traditional energy consumption from expanding transport demands is growing greenhouse gas emissions leading to environmental degradation. The study of Abbas et al. (2021) and Abbas et al. (2020a) showed that growing transportation demands and rising levels of urbanization increase environmental degradation by inducing carbon emission levels in the case of Pakistan. The findings from the study of Onifade et al. (2021b) also corroborated the assertions from Abbas et al. (2021) in the case of OPEC member countries. Air and rail transport operational schemes often require a sizeable amount of energy consumption, thereby leading to anthropogenic pollutant pollution that influences atmospheric changes over time. Several other studies have also identified the nexus between CO₂ emission and transportation (Abdallah et al., 2013; Abbass et al., 2020b). The buildup of ecological pollutants shows air contamination and such environmental degradation stands to pose some economic impacts, especially in the long run. A number of studies have found a clear correlation between the use of energy from the transport industry and economic growth (Saidi et al., 2018; Beyzatlar et al., 2014).

Economic progress and the tourism industry are among the major factors that influence the presence and amount of emissions from the transport industry as seen in the study of Küçükönal and Sedefoğlu (2017). These factors are intertwined and rely on one another. Urbanization has its role in shaping the growth of the tourism industry on one hand, while the tourism industry itself plays a significant role in influencing the growth and expansion of the transport industry. Hence, the tourism industry, urbanization, and the intensity of transport affect economic development (Arvin et al., 2015; Adedoyin & Bekun, 2020; Alola et al., 2021a, 2021b). Therefore, proper travel legislation and energy use are expected to have attendant effects on environmental degradation and economic development.

A long-term association was established regarding the levels of airline provision, change in interest duties, and stock pricing in the study of Stamolampros and Korfiatis (2019). The level of market-based ecological severity of cognitive control and inhabitants' contact was also significantly linked. The positive association between population exposures to emissions steadily decreases with tighter environmental regulations. The number of departures on the paths that are experiencing liberalization was found to be growing in contrast to those regulated by strict bilateral air travel contracts, while the slightly liberalized paths are more frequent than entirely liberalized paths (Abate, 2016). Meanwhile, there is also a long-run balance between economic development and local air traveler circulation. There is a short-run uni-directional association from local air traveler transport to economic development (Hu et al., 2015). Economic development and demand for air travel are co-integrated, showing a rise in demand for air conveyance because of extensive economic events according to Marazzo et al. (2010). Economic growth has a long-term impact on the number of passengers arranged to catch a trip and air traveler circulation, with the same

impact on the number of properties (volumes of air cargo) elated by air (Hakim & Merkert, 2016). However, air financing schemes substantially improve traffic movements and travel conditions and boost the gross value added to the economy for tourism and business passengers (Smyth et al., 2012).

2.2 Gaps in the existing studies

In the extant studies, some common issues can be identified. Firstly, analysis in some of the extant studies concentrated solely on the relationship between economic growth the environment thereby checking the validity of the EKC. Secondly, some other studies extend beyond only examining the validity of the EKC by looking at other energy and macro-variables that are correlated with ecological dilapidation. Thirdly, most studies indicate the worsening impact of non-renewable energy on the climate thereby justifying the need for cleaner forms of energy. Nevertheless, while there is no agreement on the validity of the EKC, many studies have also ignored some salient issues like urbanization and the impacts of various forms of transportation, especially air transport and rail transport. Furthermore, there is no consensus on the presence of EKC owing to diverse reasons such as the short-falls in empirical techniques and the unique properties that characterize the understudied variables. Hence, this paper seeks to extend the frontiers of knowledge by exploring the combined roles of the air and rail transport industries in environmental pollution alongside the impacts of conventional energy use and urbanization within the framework of the EKC specifically for the E7 economies. The study is better conducted within the framework of the EKC considering that economic progress is a focal theme that shapes policy formations and implementations among the emerging group of seven (E7) countries.

3 Data and methodology

This study employed a panel of seven emerging economies (E7) of the world, including China, India, Brazil, Mexico, Russia, Indonesia, and Turkey starting from 1995 to 2016 with data sourced from the World Bank development indicator (WDI) database. The choice of the period for the study is restricted to the availability of data and given the characteristic differences in the population size of the countries, we opted for the per capita scale of measurement. Table 2 summarizes the description of the variables, while a further description of the properties of the variables is provided in Tables 3 and 4 in the Appendix.

3.1 Carbon dioxide emissions per capita (CO₂)

This variable is used as the model's dependent variable as the proxy for measuring the level of environmental quality depletion. The unit of measurement of carbon dioxide emissions is provided in metric tons per capita. The apriory expectation of this variable can either be positive or negative. A positive change from explanatory variables would suggest rising environmental degradation, whereas the negative change indicates environmental sustainability.

Table 2 Description of variables

Name of Indicator	Abbreviation	Proxy/Scale of Measurement	Source
Carbon dioxide emissions per capita	CO ₂	measured in metric tonnes	WDI
Income	Y	it is proxied by the gross domestic product per capita (2010 Constant USD)	WDI
Air transport	AT	passengers carried	WDI
Square of Income	Y ²	it measures the square of GDP per capita	WDI
Fossil fuel	FF	Fossil fuel energy consumption (% of total)	WDI
Railway transport	RT	passengers carried	WDI
Urban population	UB	(% of total population)	WDI

Source: Authors compilation here WDI represents World Bank development indicator database

Table 3 Descriptive statistics

	CO ₂	Y	Y ²	AT	RT	FF	UP
Mean	13.5784	8.4931	16.9863	17.4504	10.3918	4.3266	4.0321
Median	13.1058	8.9521	17.9043	17.3010	9.7891	4.4240	4.2216
Maximum	16.1534	9.5512	19.1025	20.0057	14.0449	4.5253	4.4548
Minimum	12.0551	6.5141	13.0283	15.8630	4.2046	3.9380	3.2811
Std. Dev	1.0838	0.8607	1.7214	0.8952	2.5942	0.1869	0.3688
Skewness	0.7743	-0.7533	-0.7533	0.6045	-0.5038	-0.5293	-0.6916
Kurtosis	2.6278	2.2103	2.2103	3.0167	2.6629	1.7247	2.0231
Jarque-Bera	16.2794***	18.5688***	18.5688***	9.3818***	7.2455**	17.6267***	18.4010***
Probability	0.0002	0.0000	0.0000	0.0091	0.026	0.0001	0.0001
Observations	154	154	154	154	154	154	154

Table 4 Correlation matrix

	CO ₂	Y	AT	RT	FF	UP
CO ₂	1					
<i>p</i> -value	-					
Y	-0.3340***	1				
<i>p</i> -value	(0.0000)	-				
AT	0.5520***	0.1387*	1			
<i>p</i> -value	(0.0000)	(0.0862)	-			
RT	0.3732***	0.2880***	0.454***	1		
<i>p</i> -value	(0.0000)	(0.0003)	(0.0000)	-		
FF	0.3290***	0.3255***	0.3800***	0.4562***	1	
<i>p</i> -value	(0.0000)	(0.0000)	(0.0000)	(0.0000)	-	
UP	-0.5072***	-0.1908**	-0.0439	-0.6137***	-0.5348***	1
<i>p</i> -value	(0.0000)	(0.0177)	(0.5887)	(0.0000)	(0.0000)	-

3.2 Income (Y)

This variable is used as an explanatory variable to proxy for economic growth across the countries under consideration. The income values are transformed from the local currencies to the United States' dollars by applying the current exchange rate. A positive change in the income values of the panel countries would indicate economic growth that encourages environmental degradation.

3.3 Fossil fuel (FF)

This is one of the explanatory variables in the model that is proxied for a non-renewable source of energy as well as a control variable in the model. Energy consumption by Fossil Fuel is a composition of the following products, namely: natural gas, oil, coal, and petroleum. A positive change in the fossil fuel value with regards to apriority expectation would imply a detrimental effect on the environmental sustainability of the panel countries.

3.4 Air transport (AT)

This is another independent variable that is proxied by passengers who travel by air. Air passengers carried include both domestic and international aircraft passengers of air carriers registered in the country. A positive change in air transport signifies depletion of the environmental quality and vice versa.

3.5 Railway transport (RT)

This is another independent variable that is proxied by passengers who travel by train. Passengers carried by railway are the number of passengers transported by rail times kilometers traveled. A positive change in train transport signifies problems for the environment and vice versa.

3.6 Urban population (UB)

This is another independent variable that is proxied by the people living in the urban areas. Urban population refers to people living in urban areas as defined by national statistical offices. A negative significant change would indicate that proper measures are taken to reduce pollutants in the urban and vice versa.

Equations 1 and 2 present the model subject of our analysis showing the underlying relationship among the variables in the study with respect to the dependent variable and the corresponding regressors or explanatory variables. Firstly, Eq. 1 is the simple functional form:

$$CO_{2i,t} = f\left(Y_{i,t}, Y_{i,t}^2, AT_{i,t}, RT_{i,t}, FF_{i,t}, UP_{i,t}\right) \quad (1)$$

Secondly, Eq. 1 in its natural logarithm form is expressed to ensure homoscedasticity of the coefficients representing the elasticities of the relationships under investigation as shown in Eq. 2:

$$\ln \text{CO}_{2i,t} = \beta_0 + \beta_1 \ln Y_{i,t} + \beta_2 \ln Y_{i,t}^2 + \beta_3 \ln AT_{i,t} + \beta_4 \ln RT_{i,t} + \beta_5 \ln FF_{i,t} + \beta_6 \ln UP_{i,t} + \varepsilon_{i,t} \quad (2)$$

Given that i and t signify the cross-sectional and time units of the study (1995–2016) as mentioned earlier, whereas ε captures the error term. Please refer to Table 2 for the explanation of other variables as presented earlier.

Besides the preliminary investigations, the cross-sectional dependency test was carried out by utilizing three estimation techniques, namely Pesaran (2007) CD test, Pesaran (2015) LM test, and Breusch and Pagan (1980) LM test as well as the slope homogeneity test and the outcome informed an appropriate panel unit root test. The panel cointegration test proposed by Westerlund (2007) was adopted to validate a long-run relationship among the variables. The uniqueness of this test is based on its ability to accommodate cross-sectional unit-specific trend and slope parameters as well as the cross-sectional unit-specific short-run dynamics. We then proceeded to estimate the Kuznets curve given that a long-run relationship exists and the coefficients were later obtained using the Augmented Mean Group (AMG) by Eberhardt and Bond (2009), Common Correlated Effects Mean Group (CCEMG), and Driscoll-Kraay as proposed by Pesaran (2006) and extended by Kapetanios et al. (2011). These models have the unique ability to accommodate cross-sectional dependence and slope heterogeneity. They maintain a distinct path by how common correlated effects are treated. Whereas the CCEMG treats the effect of the parameters, the case is different for AMG because these effects signify a dynamic process that is common, and subtracting it from the dependent variable allows it to be accounted for. Finally, the pairwise granger causality test was adopted to determine the direction of causality for policy implications.

4 Empirical results and discussion

The empirical investigation begins with the delta analyses as well as a cross-sectional dependency test. From the findings in Table 5, the null assumption of no cross-sectional dependency is strongly affirmed for the data set. Thus, the presence of cross-sectional dependency in the model is not obtained. Furthermore, the null assumption of slope homogeneity by the delta analysis is dismissed at a 1% level of significance, indicating slope heterogeneity.

Table 6 reports the second-generation panel unit-root test designed to account for the degree of integration in the variables under consideration. The cross-sectionally augmented IPS (CIPS) panel unit root test as proposed by Pesaran (2007) does not necessarily require the estimation of factor loading to eliminate cross-sectional dependence. However, it incorporates lagged cross-sectional mean and its first difference which is necessary and sufficient to capture the cross-sectional dependence that arises through a single-factor model. We observe from Table 6 that all of the variables in both the unit root test methods are significant at the first difference at 1%. Therefore, the results reported in Table 6 support the presence of unit root in all the variables listed under review.

Table 7 reports the error-correction-based panel cointegration tests as proposed by Westerlund (2007). Westerlund cointegration test is a robust cointegration procedure that

Table 5 Cross-sectional dependency (CD) test results

Model	Pesaran(2007) CD Test	Pesaran(2015) LM Test	Breusch and PaganLM test	Slope Homogeneity Test	<i>p</i> -value
CO ₂ =f(Y,Y ² ,AT,RT,FF,UP)	-0.874*** (0.0023)	-1.588** (0.012)	114.85*** (0.0000)	Delta_tilde Adj. Delta_tilde	8.584*** 8.368***
<i>p</i> -value					(0.000) (0.000)

***, ** is 1% and 5% significance level

Table 6 Panel IPS and CIPS unit root test

Variables	CIPS				IPS			
	I(0)		I(1)		I(0)		I(1)	
	C	C&T	C	C&T	C	C&T	C	C&T
CO ₂	-3.183	-2.682	-4.283***	-4.170***	-1.085	-2.214	-4.306***	-4.225***
Y	-0.806	-1.071	-2.582***	-3.008***	1.783	-1.239	-2.661***	-3.348***
Y ²	-0.816*	-0.068	-3.482***	-2.571**	1.323	0.159	-3.896***	-3.193***
AT	-1.882	-2.043	-4.192***	-4.229***	0.2683	-1.727	-5.383***	-5.637***
RT	-1.600	-2.187	-3.967***	-4.144***	0.869	-0.495	-4.460***	-4.982***
FF	-1.733	-2.197	-4.004***	-4.008***	-1.336	-2.620	-5.346***	-5.293***
UP	-1.090	-1.706	-3.116***	-4.579***	1.485	-0.351	-2.209***	-3.607***

***, ** and * are 1%, 5% and 10% significance level, respectively, while C=constant and C&T=Constant and trend, respectively

Table 7 Westerlund (2007) cointegration test

Statistics	Value	p-value
Gτ	-1.553**	(0.043)
Gα	-2.271**	(0.029)
Pτ	-5.588***	(0.009)
Pα	-1.742**	(0.012)

*** and ** are 1% and 5% significance level, respectively

accounts for cross-sectional dependence with four normally distributed tests, namely, Gτ, Gα, Pτ, and Pα. The assumption of unit-specific error correction parameters is the basis upon which the first two tests are premised, hence, they are mean-group tests. In contrast, the latter tests are premeditated on the assumption of common error-correction parameters across cross-sectional units. These tests account for cross-sectional unit-specific trend and slope parameters as well as the cross-sectional unit-specific short-run dynamics. The results obtained from Westerlund’s test are robust and consistent. All the test results confirm the panel cointegration at 1% and 5% levels of significance. These results support the presence of a long-run relationship between carbon dioxide emissions, income per capita and the square of income per capita, air transport, railway transport, fossil fuel, and urban population across the (E7) economies.

4.1 The EKC and long-run coefficient analysis

Table 8 shows the results of the empirical regression model and the outcomes of this model are consistent with other empirical evidence archived in the literature; however, the level of significance differs. We proceeded to estimate the long-run coefficients given the results of the panel cointegration that support the presence of a long-run relationship between carbon dioxide emissions and its determinants. The methodologies employed are unique and capable of ensuring robust results. The results of the techniques employed are thus reported in Table 8.

Table 8 AMG, CCEMG, and Driscoll-Kraay result

Variables	AMG	CCEMG	Driscoll-Kraay
Y	0.4826***	0.3278*	0.3889***
<i>p</i> -value	(0.001)	(0.060)	(0.000)
Y ²	-0.2413***	-0.1984***	-0.1886**
<i>p</i> -value	(0.001)	(0.003)	(0.052)
AT	0.0728**	0.0220**	0.0769***
<i>p</i> -value	(0.028)	(0.039)	(0.000)
RT	-0.0441**	-0.0298**	-0.1632***
<i>p</i> -value	(0.015)	(0.019)	(0.000)
FF	1.1697**	0.4252**	0.6527***
<i>p</i> -value	(0.011)	(0.015)	(0.009)
UP	-0.0998**	-0.4853**	-2.3984***
<i>p</i> -value	(0.020)	(0.029)	(0.000)
Wald test	18.32***	12.51***	849.05***
<i>p</i> -value	(0.0026)	(0.0051)	(0.0000)
No. Regressors	6	6	6
No. Observations	154	154	154
No. Group	7	7	7
R ²			0.8524

***, ** and * are 1%, 5% and 10% significance level, respectively

From the empirical results, we observe a positive and negative sign for income per capita and the square of income per capita, and this finding is statistically significant at 1% and 10% accordingly across the different techniques employed. This result is an indication of an inverse U-shaped relationship between the variables under review. The result of a positive and significant effect of income per capita on carbon emissions and the negative and significant values of income per capita square support the EKC concept. The presence of EKC affirms the findings of Sarkodie and Adams (2018) and Erdogan et al. (2020). From the result, it can be seen that the EKC system functions correctly, and economic progress can worsen climate factors at the initial phase of economic development. However, shifting through the turning point of income class implies that pollutant emissions will decrease with continued economic growth.

Moreover, from all the estimations, it was observed that airline business indicates a positive and significant impact, while railway business indicates a negative and significant impact on environmental degradation. Subsequently, a percentage change in the number of airline passages will rise pollution by about 2.2% to 7.69%. In contrast, a percentage change in the number of railway passengers will reduce pollution by about 1.63% to 4.41%, and these outcomes affirm the result of Erdogan et al. (2020). Schäfer and Waitz (2014) have stressed that the disregard of the aviation business for environmental pollution is unavoidable since it is among the quickest developing sectors. Chapman (2007) stressed that the aviation sector's ecological impact is even greater than just releasing pollution, owing to its impact on the higher ozone, which aggravates the quality of the environment. On the other hand, Erdogan et al. (2020) have stressed that expanding the usage of the train is an effective solution for decreasing the pollution impact of the aviation sector and our finding upholds this assertion considering that rail transport shows a negative impact on environmental pollution among the E7. Besides, in other climes, the Department for Transport of

the UK (2004) has also announced that the analytical results of aviation and train sectors are in accordance with environmental concerns prediction.

Furthermore, the result from all three techniques also proves that non-renewable energy intake has a negative and significant impact on pollution. The result shows that a percentage change in fossil fuel intake increases pollution within the range of 0.43% to 1.17% and thus affirms the findings of Gyamfi et al. (2020b) and Sarkodie and Adams (2018). The fossil fuel-led pollution may be due to the distribution and reliance on non-renewable energy demand across the surveyed nations. According to the WDI (2019), the average portion of non-renewable energy in the energy mix of the surveyed nations was 67.93%, whereas the share of clean energy usage was averaged at 32.07% in the overall energy usage. Thus, the dominance of non-renewable energy usage with little or no renewable contribution constitutes the main obstacle to ecological protection. Consequently, an aspect of the key strategy ramifications, as well as consideration on the ways of increasing healthy environment, is decreasing non-renewable energy usage which can hinder economic growth within the surveyed nations.

Urbanization has a negatively significant impact on pollution in all three estimation techniques, affirming the findings of Sarkodie et al. (2020). The decreasing impact of urbanization can be due to the successful introduction of pollution control and fiscal strategies in large cities relative to the rural environment. It has been observed that towns have more access to better learning, leading to increased knowledge on ecological challenges and the need for a healthy ecosystem (Sarkodie et al., 2020). The increased prevalence of well-educated persons will force the stakeholders to expand more restorative practices. Hence, systemic change in the environment will leap and the structural impact of EKC will arise. In fact, cities are a center of R&D operations, creativity, and technical development.

5 Concluding remarks and policy implications

Environmental issues ranging from global warming, climate change issues, and environmental risk have become pertinent risk threats to environmental sustainability which has remained the major preoccupation of most policy administrators, researchers, and stakeholders. One of the prominent risk threats is the effect of greenhouse gases (GHGs) which includes carbon dioxide (CO₂) emissions. The extant literature has documented studies on the income-energy-environment nexus. However, the impacts of air and rail transportation amid the growing urban population in emerging blocs like E7 economies have received little or fewer entries.

Thus, this study bridges this gap by examining the effect of the urban population, rail and air transportation in the traditional EKC setting. This study augments the traditional EKC using second-generational techniques such as Augmented Mean Group, Common Correlated Effects Mean Group estimator; Driscoll-Kraay. Our empirical result validated the EKC concept for E7 economies. This suggests that the E7 economies are still at the scale stage of their economic path where the focus is on their economic growth relative to environmental concerns. The plausible explanation for this is the fact that the bloc mainly consists of newly industrialized nations where primary sectors drive economic activities.

Additionally, we observed the positive and statistically significant relationship between fossil-fuel energy and pollution (CO₂ emission) in the E7 economies. This evidence explains that the E7 economies are yet to make the necessary transition from conventional energy to renewables which is the ultimate chase in an era of global consciousness.

Furthermore, air transport in E7 economies also induces CO₂ emission, while rail and urban populations are inversely related to CO₂ emissions. This may be attributed to effective mitigation emissions taxation policies strategies in E7 and urban population awareness in the metropolitan cities compared to her rural counterparts.

Conclusively, our study draws the attention of policymakers and the authorities in the E7 to the crucial roles of rail transport. The findings imply that for the E7 to maximize the ample opportunities that the rail sector offers in terms of environmental sustainability and economic development, the authorities must outline appropriate strategies to ensure more investment in the improvement of rail transport operations in the bloc. This is very important for two main reasons; firstly, there are more environmental advantages in this means of transport as it produces fewer direct pollutants into the atmosphere, and secondly, rail transport also acts as a more efficient means of mass transportation in times of growing urbanization that has necessitated higher energy consumption and growing transport demands.

Furthermore, there is a need to reinforce the commitment to energy mix transition from traditional energy to renewable energy sources among the E7 countries. More priority has to be placed on lower-carbon fuels for the fuel mix in all forms of transportation and most, especially for air transport to help sustain the environment. This can be achieved via the channel of research and development of efficient fuel airplanes that are ecosystem-friendly.

The authorities in each of these E7 countries certainly have crucial roles to play as far as environmental protection is concerned, and there might also be problems relating to issues of commitment to environmental treaties and strategies. Although this study has addressed other pertinent issues, it has, however, sideline the aspects relating to governance and institutional quality. Hence, future research can examine the roles of institutional quality among the E7 countries within the existing framework of the current study.

Appendix

See Tables 3 and 4.

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Declarations

Ethical approval Authors mentioned in the manuscript have agreed for authorship read and approved the manuscript, and given consent for submission and subsequent publication of the manuscript.

Consent to participate Note Applicable.

Consent to publish Applicable.

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References

- Abate, M. (2016). Economic effects of air transport market liberalization in Africa. *Transportation Research Part a: Policy and Practice*, 92, 326–337. <https://doi.org/10.1016/j.tra.2016.06.014>
- Abbas, S., Shirazi, S. A., Hussain, M. S., Yaseen, M., Shakarullah, K., Wahla, S. S., & Khurshid, M. (2020b). Impact of climate change on forest cover: Implications for carbon stock assessment and sustainable development in HKH region-Pakistan.
- Abbas, S., Kousar, S., & Pervaiz, A. (2021). Effects of energy consumption and ecological footprint on CO₂ emissions: an empirical evidence from Pakistan. *Environment, Development and Sustainability*, 2021, 1–18.
- Abbas, S., Kousar, S., Yaseen, M., Mayo, Z. A., Zainab, M., Mahmood, M. J., & Raza, H. (2020a). Impact assessment of socioeconomic factors on dimensions of environmental degradation in Pakistan. *SN Applied Sciences*, 2(3), 1–16.
- Abdallah, K. B., Belloumi, M., & De Wolf, D. (2013). Indicators for sustainable energy development: A multivariate cointegration and causality analysis from Tunisian road transport sector. *Renewable and Sustainable Energy Reviews*, 25, 34–43.
- Adedoyin, F. F., & Bekun, F. V. (2020). Modelling the interaction between tourism, energy consumption, pollutant emissions and urbanization: Renewed evidence from panel VAR. *Environmental Science and Pollution Research*, 27(31), 38881–38900.
- Adedoyin, F. F., Gumede, I. M., Bekun, F. F., Etokakpan, U. M., & Balsalobre-lorente, D. (2020). Modelling coal rent, economic growth and CO₂ emissions: Does regulatory quality matter in BRICS economies? *Science of the Total Environment*, 710, 136284. <https://doi.org/10.1016/j.scitotenv.2019.136284>
- Air Transport Action Group, 2019. Fact & Figures. Retrieved from. <https://www.atag.org/facts-figures.html>.
- Alola, A. A., Adebayo, S., & Onifade, S. T. (2021). Examining the dynamics of ecological footprint in China with spectral Granger causality and Quantile-on-Quantile approaches. *International Journal of Sustainable Development & World Ecology*.
- Alola, A. A., Lasisi, T. T., Eluwole, K. K., & Alola, U. V. (2021a). Pollutant emission effect of tourism, real income, energy utilization, and urbanization in OECD countries: A panel quantile approach. *Environmental Science and Pollution Research*, 28(2), 1752–1761.
- Apergis, N., & Payne, J. E. (2012). The electricity consumption-growth nexus: Renewable versus non-renewable electricity in Central America. *Energy Sources, Part B: Economics, Planning, and Policy*, 7, 423–431. <https://doi.org/10.1080/15567249.2011.639336>
- Arvin, M. B., Pradhan, R. P., & Norman, N. R. (2015). Transportation intensity, urbanization, economic growth, and CO₂ emissions in the G-20 countries. *Utilities Policy*, 35, 50–66.
- Aslan, A., Destek, M. A., & Okumus, I. (2018). Bootstrap rolling window estimation approach to analysis of the Environment Kuznets Curve hypothesis: Evidence from the USA. *Environmental Science and Pollution Control Series*, 25(3), 2402–2408.
- Bekun, F. V., Gyamfi, B. A., Onifade, S. T., & Agboola, M. O. (2021). Beyond the environmental Kuznets Curve in E7 economies: Accounting for the combined impacts of institutional quality and renewables. *Journal of Cleaner Production*. <https://doi.org/10.1016/j.jclepro.2021.127924>
- Beyzatlar, M. A., Müge, K., & Hakan, Y. (2014). Granger-causality between transportation and GDP: A panel data approach. *Transportation Research Part a: Policy and Practice*, 63, 43–55.
- Bows, A., Anderson, K., & Peeters, P. (2009). Air transport, climate change and tourism. *Tourism and Hospitality Planning & Development*, 6(1), 7–20.
- 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.
- Chapman, L. (2007). Transport and climate change: A review. *Journal of Transport Geography*, 15(5), 354–367.
- Cowan, W. N., Chang, T., Inglesi-Lotz, R., & Gupta, R. (2014). The nexus of electricity consumption, economic growth and CO₂ emissions in the BRICS countries. *Energy Policy*, 66, 359–368.
- Department of Transport, 2004. The Future of Transport a Network for 2030. Retrieved from file:///C:/Users/Sinan/Downloads/The_Future_of_Transport_-_A_Network_for_2030.pdf.
- Eberhardt, M., & Bond, S. (2009). Cross-section dependence in nonstationary panel models: a novel estimator.
- Erdogan, S., Adedoyin, F. F., Bekun, F. V., & Sarkodie, S. A. A. (2020). Testing the transport-induced environmental Kuznets curve hypothesis: The role of air and railway transport. *Journal of Air Transport Management*, 89, 101935.

- Grossman, G. M., & Krueger, A. B. (1991). Environmental Impacts of a North American Free Trade Agreement (Retrieved from).
- Gyamfi, B. A., Bein, M. A., & Bekun, F. V. (2020b). Investigating the nexus between hydroelectricity energy, renewable energy, and non-renewable energy consumption on output: evidence from E7 countries. *Environmental Science and Pollution Research International*, 27, 25327–25339.
- Gyamfi, B. A., Bein, M. A., Ozturk, I., & Bekun, F. V. (2020a). The moderating role of employment in an environmental Kuznets curve framework revisited in G7 countries. *Indonesian Journal of Sustainability Accounting and Management*, 4(2), 241.
- Gyamfi, B. A., Onifade, S. T., Nwani, C., & Bekun, F. V. (2021). Accounting for the combined impacts of natural resources rent, income level, and energy consumption on environmental quality of G7 economies: A panel quantile regression approach. *Environmental Science and Pollution Research*. <https://doi.org/10.1007/s11356-021-15756-8>
- Hakim, M. M., & Merkert, R. (2016). The causal relationship between air transport and economic growth: Empirical evidence from South Asia. *Journal of Transport geography*, 56, 120–127.
- Hu, Y., Xiao, J., Deng, Y., Xiao, Y., & Wang, S. (2015). Domestic air passenger traffic and economic growth in China: Evidence from heterogeneous panel models. *J. Airtransport. Manag.*, 42, 95–100. <https://doi.org/10.1016/j.jairtraman.2014.09.003>
- Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of Economics*, 115(1), 53–74.
- IPCC. (1999). *Intergovernmental Panel on Climate Change: Aviation and the Global Atmosphere. A Special Report of IPCC Working Groups I and III*. Cambridge: Cambridge University Press.
- Jebli, M. B., Youssef, S. B., & Ozturk, I. (2016). Testing environmental Kuznets curve hypothesis: The role of renewable and non-renewable energy consumption and trade in OECD countries. *Ecological Indicators*, 60, 824–831.
- Kommenda, N., (2019). How your flight emits as much CO2 as many people do in a year. The Guardian. Retrieved from. <https://www.theguardian.com/environment/ng-interactive/2019/jul/19/carbon-calculator-how-taking-one-flight-emits-as-much-as-many-people-do-in-a-year>
- Küçükönal, H., & Sedefoğlu, G. (2017). The causality analysis of air transport and socio-economics factors: The case of OECD countries. *Transportation Research Procedia*, 28, 16–26. <https://doi.org/10.1016/j.trpro.2017.12.164>
- Kuznets, S. (1955) Economic growth and income inequality. *Am Econ Rev* 45(1):1–28 <https://www.jstor.org/stable/1811581>. Accessed September 2021
- Marazzo, M., Scherre, R., & Fernandes, E. (2010). Air transport demand and economic growth in Brazil: A time series analysis. *Transportation Research Part E: Logistics and Transportation Review*, 46, 261–269. <https://doi.org/10.1016/j.tre.2009.08.008>
- Onifade, S. T., Alola, A. A., Erdoğan, S., & Acet, H. (2021b). Environmental aspect of energy transition and urbanization in the OPEC member states. *Environmental Science and Pollution Research*, 28(14), 17158–17169. <https://doi.org/10.1007/s11356-020-12181-1>
- Onifade, S. T., Erdoğan, S., Alagöz, M., & Bekun, F. V. (2021a). Renewables as a pathway to environmental sustainability targets in the era of trade liberalization: Empirical evidence from Turkey and the Caspian countries. *Environmental Science and Pollution Research*. <https://doi.org/10.1007/s11356-021-13684-1>
- Ouyang, X., Shao, Q., Zhu, X., He, Q., Xiang, C., & Wei, G. (2019). Environmental regulation, economic growth and air pollution: Panel threshold analysis for OECD countries. *Science of the Total Environment*, 657, 234–241. <https://doi.org/10.1016/j.scitotenv.2018.12.056>
- Ozcan, B., Tzeremes, P., & Dogan, E. (2019). Re-estimating the interconnectedness between the demand of energy consumption, income, and sustainability indices. *Environmental Science and Pollution Research*, 26, 26500–26516. <https://doi.org/10.1007/s11356-019-05767-x>
- 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>
- Pao, H. T., & Tsai, C. M. (2011). Modeling and forecasting the CO2 emissions, energy consumption, and economic growth in Brazil. *Energy*, 36, 2450–2458. <https://doi.org/10.1016/j.energy.2011.01.032>
- Pata, U. K. (2018). The influence of coal and noncarbohydrate energy consumption on CO2 emissions: Revisiting the environmental Kuznets curve hypothesis for Turkey. *Energy*, 160, 1115–1123.
- Pesaran, M. H. H. (2006). Estimation and inference in large heterogeneous panels with a multifactor error structure. *Econometrica*, 74(4), 967–1012.
- Pesaran, M. H. (2007). A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Economics*, 22(2), 265–312.

- Pesaran, M. H. H. (2015). Testing weak cross-sectional dependence in large panels. *Econometric Reviews*, 34(6–10), 1089–1117.
- RashidKhan, H. U., Siddique, M., Zaman, K., Yousaf, S. U., Shoukry, A. M., Gani, S., Sasmoko, K. A., Hishan, S. S., & Saleem, H. (2018). The impact of air transportation, railways transportation, and port container traffic on energy demand, customs duty, and economic growth: evidence from a panel of low-, middle-, and high-income countries. *Journal of Air Transport Management*, 70, 18–35. <https://doi.org/10.1016/j.jairtraman.2018.04.013>
- Saidi, S., Shahbaz, M., & Akhtar, P. (2018). The long-run relationships between transport energy consumption, transport infrastructure, and economic growth in MENA countries. *Transportation Research Part a: Policy and Practice*, 111, 78–95. <https://doi.org/10.1016/j.tra.2018.03.013>
- Sampigethaya, K., & Poovendran, R. (2013). Aviation cyber-physical systems: Foundations for future aircraft and air transport. *Proceedings of the IEEE*, 101(8), 1834–1855.
- Sarkodie, S. A., & Adams, S. (2018). Renewable energy, nuclear energy, and environmental pollution: Accounting for political institutional quality in South Africa. *Science of the Total Environment*, 643, 1590–1601.
- Sarkodie, S. A., Owusu, P. A., & Leirvik, T. (2020). Global effect of urban sprawl, industrialization, trade and economic development on carbon dioxide emissions. *Environmental Research Letters*, 15(3), 034049.
- Sarkodie, S. A., & Strezov, V. (2019a). A review on Environmental Kuznets Curve hypothesis using bibliometric and meta-analysis. *Science of the Total Environment*, 649, 128–145.
- Sarkodie, S. A., & Strezov, V. (2019b). Effect of foreign direct investments, economic development and energy consumption on greenhouse gas emissions in developing countries. *Science of the Total Environment*, 646, 862–871.
- Schäfer, A. W., & Waitz, I. A. (2014). Air transportation and the environment. *Transport Policy*, 34, 1–4.
- 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(2), 147–162.
- Shahbaz, M., Solarin, S. A., & Ozturk, I. (2016). Environmental Kuznets curve hypothesis and the role of globalization in selected African countries. *Ecological Indicators*, 67, 623–636.
- Shahbaz, M., Solarin, S. A., Sbia, R., & Bibi, S. (2015). Does energy intensity contribute to CO₂ emissions? A trivariate analysis in selected African countries. *Ecological Indicators*, 50, 215–224.
- Smyth, A., Christodoulou, G., Dennis, N., Al-Azzawi, M., & Campbell, J. (2012). Is air transport a necessity for social inclusion and economic development? *Journal of Air Transport Management*, 22, 53–59. <https://doi.org/10.1016/j.jairtraman.2012.01.009>
- Solarin, S. A. (2014). Tourist arrivals and macroeconomic determinants of CO₂ emissions in Malaysia. *Anatolia*, 25(2), 228–241.
- Stamolampros, P., & Korfiatis, N. (2019). Airline service quality and economic factors: An ARDL approach on US airlines. *Journal of Air Transport Management*, 77, 24–31. <https://doi.org/10.1016/j.jairtraman.2019.03.002>
- Ulucak, R., & Bilgili, F. (2018). A reinvestigation of EKC model by ecological footprint measurement for high, middle and low income countries. *Journal of Cleaner Production*, 188, 144–157.
- Westerlund, J. (2007). Testing for error correction in panel data. *Oxford Bulletin of Economics and Statistics*, 69(6), 709–748.
- Wong, M. S. C., Zhan, F., & Garham, D. (2018). Quantifying the substitutability and complementarity between High-speed rail and air transport. *Transport Research Part A*, 118(2018), 191–215.
- World Bank 2020. World Bank. World Dev. Indic. (<http://databank.worldbank.org/data/reports.aspx?Source=World%20Development%20Indicators#>).
- World Bank, 2019. World Development Indicators. Retrieved from. <https://databank.worldbank.org/source/world-development-indicators#>.
- Zaman, K., Shahbaz, M., Loganathan, N., & Raza, S. A. (2016). Tourism development, energy consumption and Environmental Kuznets Curve: Trivariate analysis in the panel of developed and developing countries. *Tourism Management*, 54, 275–283. <https://doi.org/10.1016/j.tourman.2015.12.001>

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