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Exploring the tourism-CO_2 emissions-real income nexus in E7 countries: accounting for the role of institutional quality

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ABSTRACT

The purpose of this study is to explore the long-run and causality relationship between tourism development and the real income level in an environmental Kuznets Curve (EKC) framework for emerging industrialised economies (E7). The newness of our study to the tourism literature is the inclusion of institutional quality and tradeto the mix. The inclusion of the additional variables in the econometrics setting is worthwhile to circumvent omitted variable bias. Second-generation panel estimation techniques, in conjunction with the Driscoll-Kraay robust estimator, have been employed to accommodate cross-sectional dependency in the panel under review, as well as for robustness of coefficients and estimates. The Empirical results affirm the presence of the EKC phenomenon and tourism-induced emission in E7 economies, thereby suggesting that sustainable tourism has a deteriorating impact on economic growth in the examined industrialised countries. Similarly, real GDP per capita and non-renewable energy also dampen the quality of the environment, as indicated by the robust regression of AMG and CCEMG. Hence, an increase in non-renewable energy and tourism demand increases CO_2emission in E7 economies. Additionally, we observe that the quality of institution improves the quality of the environment, thus, indicating that the role of good governance (institutional quality) improves the quality of the environment in E7. Furthermore, there is a need for a paradigm shift to sustainable tourism development alongside the adoption of the polluters pay principles to mitigate the adverse implications of the consumption of non-renewable energy. More insights are presented in the concluding section.

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Introduction

The tourism industry provides services and products that encourage voyagers to remain in places outside their standard climate for no more than one continuous year for

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business, recreation and other purposes**.** This is one of the world's fastest-growing industries, creating foreign exchange and opportunities for employment in international countries. It is also one of the most remarkable monetary and social phenomena. In 1997, the World Travel and Tourism Council (WTTC) anticipated that three ventures – telecommunications, information technology, and **the travel** industry, would dominate the twenty-first. Despite different homegrown and global wars, political choppiness, fear, infection, epidemics, energy emergencies, and monetary trouble on various continents, the global international tourism sector recorded 1.33 billion dollars in 2014 compared to 166 million dollars recorded in 1970 (United Nations World Tourism Organization [UNWTO], 2015).

Additionally, in 2014, the global travel industry made 1.5 trillion dollars in income profit, created more than 270 million job opportunities, and contributed to more than 9 per cent of the world's GDP (Asongu et al., 2019; Asongu & Odhiambo, 2019; Odhiambo & Nyasha, 2020; WTTC, 2015). As a result, the travel industry has profoundly affected the worldwide economy through its commitment to raising the creation of products and business ventures, improving residents' way of life, creating job openings, collecting foreign trade saves, and expanding government incomes. Besides this, the financial impact of the travel industry on the worldwide economy has been consistently on an upsurge for many decades. This was clear from the most recent annual research by the WTTC with regard to Oxford Economics. The tourism industry experienced a 3.5% improvement in 2019, exceeding the overall money-related advancement of 2.5% for the ninth progressive year. As of late, one out of four new job opportunities was created by the sector, making the Travel and Tourism industry the best assistant for governments to create more work. According to WTTC (2019), it directly or indirectly accounted for 8.9 trillion dollars to contribute to the global GDP, more than 10% of overall GDP, more than 300 million positions (1 out of 10), the foreign trade of 1.7 trillion dollars, and a capital investment of more than 900 billion dollars.

Since the vast majority of tourist activities legitimately need energy utilisation from petroleum products or by implication from the power regularly created from coal, flammable gas or oil (Paramati et al., 2017), tourists may adversely affect the climate in the form of carbon dioxide (CO_2) emission at both public and global levels. For example, according to UNWTO (2007), 5% of worldwide CO_2emissions, particularly for transportation, accommodation, and other travel **industry-related** exercises, were liable by vacationer action (Jones & Munday, 2007). Several studies have contended about how the travel industry impacts emission utilising the Environmental Kuznets Curve (EKC) hypothesis. EKC, which is an altered U-formed, is utilised to distinguish a connection between environmental degradation and income inequalities. The extant literature has documentation on the tourism-induced emission nexus for both a single country and several blocs. However, there exists little or no documentation for the role of institutional quality on the TLGH for the emerging economies, which the current study seeks to fill. Işik et al. (2020) researched on the investigation of the EKC theory for a gathering of G7 nations for the period 1995–2015. The experimental discoveries of the examined study show that tourism-initiated EKC theory exists for France only. Furthermore, it was observed in Italy that CO_2emission was positively influenced by the increase in the international tourists' arrival. Likewise, the negative influence of the tourism growth-emission nexus has been pointed out in some previous studies.

Becken and Simmons (2002), using New Zealand as a case study, revealed that a significant source for global climate change and **energy consumption is tourism** and that tourist **activities, such as** jet boating and air flight, expend greater energy than museum visits, which is one of the tourist attractions. In a similar vein, Gössling (2002) determined that the travel industry **significantly** affects energy utilisation and CO_2 emission.

Since this study is about utilising proof from institutional quality to contemplate the impacts of tourism on CO_2 emission, some past studies that influence institutional quality were featured.

Khan et al. (2020) contend that the government has an urgent role to play in amplifying the ideal motivating forces for practical financial development. To transform this into a hypothesis, the authors utilised the robust nonlinear autoregressive lag model to deal with the deviated part of institutional quality in animating the travel industry stream in Asia-Pacific nations. Their outcome uncovered that the carbon emission in the inspected nations reacts unevenly to any progressions in institutional quality. Thus, their research discovers alternative measures to the tourism-emission nexus. The institutional dimension of the EKC worldview has, likewise, been investigated in an examination by Lau et al. (2018), where they uncovered the pollution decrease impact of institutional quality. In particular, they found that the control of defilement and **the rule of law** mitigates the expansion of environmental pollutants in top-level income nations. Furthermore, the impact of the index and individual component institutional quality on international tourism demand in India was examined. The result of the study shows that the development of the tourism sector in India is as a result of effects from tourist originating countries. Among the individual segments of institutional quality, **the rule of law**, administrative quality, control of defilement and voice, and responsibility are found to advance the tourism area improvement in the economy. Conflictingly, the effect of government adequacy has been discovered to be negative (Mushtaq et al., 2021).

The economic contribution of tourism to global development cannot be underrated. However, the international arrival of tourists, as well as fossil fuels, the capital trade and the global economy have negative impacts on environmental degradation (i.e. consequent effects of carbon-dioxide emission). Carbon emissions (metric tons per capita unit) by the world, including emerging countries (China, Mexico, India, Russia, Indonesia, Brazil and Turkey), were approximately 3.8 metric tons in 1990, after which it declined in 2010. Since then, carbon emission has been on the rise until 2018, with an average rate of 4.8 metric tons. Also, as shown in Figure A1, carbon-dioxide discharge in emerging countries varies significantly. The Russian Federation, followed by China, has the highest metric tons of CO_2 emission, which suggests what E7 countries have in common about their environment – degradation is on the rise even with the advanced technology in the current century. It is with such reasons whereby the rationale behind this study arises (see appendix section for graphical display).

In line with the United Nations Sustainable Developmental Goals 7, 8, 12 and 13, which deal with ensuring that lives and communities are ameliorated by reducing to the minimum carbon dioxide emissions from greenhouse gases, encourage growth across the countries that will help sustain the environment and explore the full growth productive employment for those willing and able to work.

However, the E7 economies are regarded as the most important in receiving large tourism attractions. Tourism is experiencing rapid growth among E7 economies, and implications such as energy utilisation and CO_2 emission are on the increase. The tourism sector's CO_2 emission exposure is rising exponentially, 7.88 times higher than in 1990. This increase in the tourism sector in CO_2 emission is mainly due to transport, which accounts for more than 80% of total carbon emissions (Danish & Wang, 2018; Odhiambo, 2012; Tang, 2015). The entire world looks to the E7 economies because they have remarkable advantages to become champions worldwide, particularly in tourism. As a rising service sector, tourism needs attention and hence provides many prospects and implications to E7 eco**nomies, which hav**e a valuable contribution to the bloc (Datta, 2014). E7 economies build opportunities, earn income for their citizens and increase their economic activity by developing tourism. Tourism practices concurrently contribute to lower environmental sustainability (Banday & Ismail, 2017).

Nevertheless, Mbaiwa (2003) concluded that the deterioration of the ecosystem of tourism contributes to growing air emissions and, thus, demands environmental policies to rebuild tourism destinations. Gao et al. (2021) supported the phenomenon of the EKC caused by tourism in various Mediterranean areas with certain causal assumptions. The bi-directional assumption among tourism receipts, as well as economic development, is verified by the North, whereas the southern regions display the phenomenon of tourism-led development, which suggests a strong strategy assumption for the development of tourist facilities in the respective nations to position green tourism in reducing pollutants across the nations, as was further highlighted by Balli et al. (2019). This restricted function of tourism is linked to complex causal ties, which favour either the theory of feedback and/or the theory of tourism-led-growth (TLG) in nations. Saint Akadiri et al. (2019) used globalisation in the modelling of the inclusion of international tourism (ITOUR) and economic development (EG), and reaffirmed the facilitating function of globalisation in favour of the EKC theory, which is central to achieving the country's sustainable development objectives. Liu et al. (2019) endorsed the Sustainable Tourism (ST) initiative to help mitigate CO_2 emission, whereas EG, as well as energy consumption (ED), should appear to be the key backdrop for a wide scale of CO_2 increases in the region. Green ecological strategies are also essential to restrict detrimental external costs that are sponsored internationally by the sustainable tourism policy.

However, previous studies present inconclusive outcomes on this debate. To this end, this paper seeks to assess the role of international tourism arrival in an EKC environment for the case of emerging economies, while accounting for other key variables such as trade, i**ncome, and** institutional quality on CO_2 emission using second generational panel estimators, which ameliorate for the cross-sectional dependency and heterogeneity issues in panel data of E7 countries. Outcomes from this study will enlighten policy makers of E7 countries to address the issues on sustainable tourism and its implication for environmental sustainability.

The remainder of this study is structured as follows: Literature review is presented in Section 2 while data and econometrics sequences are reported in Section 3. Section 4 renders the empirical results. Finally, the concluding remarks and policy recommendations are offered in Section 5.

Review of related literature

Studies on energy, tourism and CO_2 emission

Although, empirically, several studies have widely talked about factors or variables that induce carbon-dioxide (CO_2) emission, most used environmental qualities and per capita income variables in Environmental Kuznets Curve (EKC) without taking into account how institutional quality (rule of law, corruption, etc.) contribute to the inducement of the emission. From the literature review, this study found that different econometric methods were employed, by various researchers, to conduct the influence of carbon emission-induced factors. Some combined two or more methods to test the effectiveness of their model. Some methods, such as ARDL, were used for the analysis of individual countries while FMOL and P-OLS were used for multi-country panel regression analysis. For example, in the case of individual analysis, Bilgili et al. (2016) investigated the seventeen OCED countries panel data for the period of 1977–2010. In the findings, the EKC hypothesis was supported, indicating that renewable energy has a negative impact on carbon emission while financial growth has a positive impact. According to Bolük and Mert's (2015) study of the Turkish nation, the assessment of EKC theory revealed that the emission of carbon in Turkey was influenced by the negative impact of electricity produced by renewable energy. Danish et al. (2017) verified that, while renewable energy does not influence emission to the environment, non-renewable energy was proved to be the major contributor.

In contrast, Jebli and Youssef (2015) studied on Tunisia panel data for the period of 1980–2009 and found that there is a connection between the EKC hypothesis on GDP and carbon emission. A similar result was presented by Zambrano-Monserrate et al.'s (2018) study on Peru from 1980 to 2011, and Chen et al.'s (2019) study on China for the period of 1980–2014. De Vita et al. (2015) assessed the EKC to control for tourism development in Turkey and found that carbon emission was cointegrated by energy consumption, income, and universal tourist arrivals. As such, these variables were said to exhibit a positive and significant impact of environmental degradation in the long run.

Regarding the multi-country panel regression analysis, Dogan and Seker (2016) used dynamic ordinary least squares (DOLS) to study the tourism-emission nexus and EKC hypothesis of sampled EU countries from 1980 to 2012. The study revealed that there occurs a positive influence of renewable energy consumption carbon emissions reduction. Likewise, different authors used different methods to study the EU countries for different periods. The outcome of their study indicates that renewable energy consumption positively influenced carbon emission (Baležentis et al., 2019).

Conversely, the EKC hypothesis was not confirmed in Al-Mulali et al.'s (2016) research which employed S-GMM to study the panel data of 58 countries for the period 1980–2009. This result is in tandem with the outcome of the study on Asian countries from 1980 to 2009 when VECM was employed (Liu et al., 2017). Samuel and Christian (2019) investigated the link between CO_2 emission and renewable energy consumption for 28 SSA countries over the historical data of 1980–2014. Their findings, using FMOLS and GMM methods of estimation, revealed that renewable together with non-renewable energy affects CO_2 emission in the long run. But CO_2 emission was discovered to be positively influenced by only non-renewable in the short run. Moreover, a certain percentage increase in urbanisation and GDP of the studied countries leads to an increase in emission of those countries. In fact, energy consumption and urbanisation globally contribute to global environmental degradation (Wang et al., 2018).

Ben Jebli et al. (2015) and Inglesi-Lotz and Dogan (2018) investigated environmental degradation in sub-Saharan Africa for a different period and their findings both indicated that environmental quality was greatly influenced by renewable energy consumption, while non-renewable energy indicates the opposite effects. The outcome of the Sinha et al. (2017) study for N-11 countries revealed that environmental degradation was positively related to trade and renewable energy whereas non-renewable energy, biomass and urbanisation have a negative effect on environmental degradation. Likewise, the panel analysis of five major countries under the EU was carried out by Balsalobre-Lorente et al. (2018) who showed that environmental quality depends largely on renewable electricity consumption and economic growth of the studied countries.

Studies on CO_2 emission and GDP growth

Furthermore, the existence of the EKC hypothesis was established for a panel of emerging countries (E7) from 1990 to 2014 (Aydoğan & Vardar, 2019). Aydoğan and Vardar (2019) studied the emission-economic growth nexus, renewable energy consumption as well as non-renewable energy, and value-added agriculture and demonstrated a positive link between carbon emission and non-renewable energy consumption, economic growth, and value-added agriculture. Additionally, the assessment of the EKC hypothesis in their study showed an inverted U-shaped resulted from the estimates of the long-run analysis. They also found the existence of bidirectional causality effects of carbon emission and non-renewable energy consumption. Doğan and Buhari also employed panel analysis of E7 countries for the period of 1990–2014 to analyse the connection between carbon discharges, financial development, energy consumption, and GDP. Their investigation yielded that there is no long-term relationship between financial development and carbon discharges. A unit per cent expansion of GDP and energy consumption expands carbon emanations by 1.8% and 0.2% increments, respectively.

Some scholars, although very few, have researched and studied the impact of institutional quality on tourism. Ghalia et al. (2019) linked the role of institutional quality to the global emission by examining the EKC hypothesis. They ran sampled panel data of 100 developed and developing countries using generalised method of moment (GMM) estimators. Their result indicated a U-shaped inverted connection between GDP and CO_2 emissions only in developed countries but not in the developing ones. Furthermore, some institutional quality indices, such as rule of law, were detected to have an important consequence on the environment of all countries except for low-income ones. Their overall result suggested that institutional quality globally reduced CO_2 emission. Another study conducted by Italo (2012) examined the impact of the institutional quality variables and carbon emission by assessing the EKC hypothesis. His study employed a standard reduced-form modelling approach with pool estimation on 18 Latin American economies and panel data from 1998 to 2005. To measure the heterogeneity of each country, three different models, one of which was EKC, was introduced. The result from the study supports the EKC hypothesis while confirming the importance of institutional quality for improved environmental performance in the region.

This study is distinct from the ones conducted by Aydoğan and Vardar (2019) and on E7 countries, because it is the first of its kind to link institutional quality indices to tourism, trade, income and energy consumption in E7 countries.

Data and methodology

This study employed a panel regression for 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. Table 1 gives a summary of the description of the variables, and further discussion of the variables of interest will follow.

However, we control for the impacts of Tourist Arrivals (T), Income (Y) and its square (Y^2), Institutional Quality (I) and Trade (O) among the countries in line with the growing relevance of these variables in the literature (Sarpong et al., 2020; Shahzad et al., 2017; Wang et al., 2021).

Underneath the Environmental Kuznets Curve (EKC) theory, the association regarding income and environmental degradation has been commonly investigated. The EKC theory notes that environmental degradation worsens in early stages of economic growth before it exceeds a specific per capita income standard, after which it starts to decline. Following Grossman and Krueger's (1991) initial research, several investigations examined the validity of the EKC theory, leading to conflicting findings (Bekun et al., 2021a, 2021b; Gyamfi et al., 2021a; Kurniawan & Managi, 2018). In order to test the relevance of the EKC theory, previous literature typically involve economic growth or income denoted by (Y) as well as its square on CO_2emission estimation which will be presented as a function of a carbon-income function as presented in Equation (1).

$$CO_{2i,t} = f(Y_{i,t}, Y^2_{i,t}, T_{i,t}, O_{i,t}, F_{i,t}, I_{i,t}) \quad (1)$$

Secondly, the above equation in its natural logarithm form is expressed to ensure homoscedasticity of the coefficients representing the elasticities of the relationships under investigation:

$$\ln CO_{2i,t} = \beta_0 + \beta_1 \ln Y_{i,t} + \beta_2 \ln Y^2_{i,t} + \beta_3 \ln T_{i,t} + \beta_4 \ln O_{i,t} + \beta_5 \ln F_{i,t} + \beta_6 \ln I_{i,t} + n_{i,t} \quad (2)$$

Table 1. Description of variables.

Name of indicator	Abbreviation	Proxy/scale of measurement	Source
Carbon Dioxide Emissions per Capita	CO_2	Measured in metric tones	WDI
Income	Y	Proxied by the gross domestic product per capita (2010 Constant USD)	WDI
Tourist Arrivals	T	Number of arrivals	WDI
Square of Income	Y^2	Measures the square of GDP per capita	WDI
Fossil Fuel	F	Fossil fuel energy consumption (% of total)	WDI
Trade	O	Trade (% of GDP)	WDI
Institutional Quality	I	CPIA transparency, accountability, and corruption in the public sector rating	WDI

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 1 for the explanation of other variables as presented earlier.

Besides the preliminary investigations, the cross-sectional dependency will be carried out and the outcome will inform an appropriate panel unit root test. The panel cointegration test proposed by Westerlund (2007) will be adapted to validate long-run relationships among the variables. The uniqueness of this test is the ability to accommodate cross-section unit-specific trend and slope parameters as well as the cross-section unit-specific short-run dynamics. We will proceed to estimate the Kuznets curve given that a long-run coefficient and relationship use the Augmented Mean Group (AMG) by Eberhardt and Bond (2009), Common Correlated Effects Mean Group (CCEMG), and Driscoll-Kraay as proposed by Driscoll and Kraay (1998) 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, by 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.

Carbon Dioxide Emissions per Capita (CO_2): This variable is used as the dependent variable in the model as the proxy for the environment. The unit of measurement of carbon dioxide emissions is in metric tons per capita. The a priori expectation of this variable can either be positive or negative. A positive change in carbon dioxide emissions would suggest environmental degradation whereas the negative change indicates environmental sustainability.

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 United States dollars by applying the current exchange rate. A positive change in the income values of the panel countries would indicate economic growth.

Tourist Arrivals (T): This is another independent variable that is proxied for tourism. This tourism variable measures the number of international tourists who visit and stay within the confines of tourist establishments. A positive change in tourist arrivals signifies gains from tourism while a negative change indicates that tourism has no significant benefit.

Fossil Fuel (F): 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. Fossil fuel of energy consumption is a composition of the following products: natural gas, oil, coal, and petroleum. A positive change in the fossil fuel value with regard to a priority expectation would imply a detrimental effect on the environmental sustainability of the panel countries.

Trade (O): This variable is the summation of exports and imports of goods and services measured as a percentage of the gross domestic product. It is used as an independent variable in the model. The changes in the value of this variable will have a considerable effect on the environmental degradation of the panel countries.

Institutional Quality (I): The CPIA transparency, accountability and corruption in the public sector are proxied for institutional quality. This independent variable ensures that accountability is seen from the executive with regard to the disbursement of funds by the electorate and as well as the legislature and the judiciary. The variable covers three major areas, which include accountability of the executive to ensure proper monitor of the institutions as well as the performance of the public employees; ensuring that information on public affairs is readily available by the civil society, and the narrow-vested interest as captured by the state.

Empirical results and discussion

This study begins with some preliminary empirical analysis and captures the variables used and reports the descriptive statistics in Table 2 as being normally distributed. From the summary statistics, there is a considerable gap between the minimum and maximum values for the period in view. Tourist arrivals are observed to have the highest average and maximum value followed by carbon dioxide emissions, while institutional quality has the lowest average within the period of investigation. Table 3 reports the correlation matrix of the variables over the period. We observed from the table positive and negative statistically significant relationships among the variables under review. Specifically, a positive and significant relationship between tourist arrivals, fossil fuel energy consumption, institutional quality, and carbon dioxide emissions exist. This implies that an increase in the number of international tourists who visit and stay within tourist establishments will lead to an increase in carbon dioxide emissions of the countries under investigation. Also, increases in energy consumption of fossil fuel, as well as institutional quality, increase environmental degradation. Similarly, a negative and significant relationship is observed between economic growth and carbon dioxide emissions, as well as economic growth and institutional quality. This implies that an increase in the economic output of the panel countries will lead to a reduction in carbon dioxide emissions, thereby improving environmental quality. In the same vein, there is an implication that economic growth reduces institutional quality. These positions will be further validated in the course of the study.

Table 3 reports the result of the cross-sectional dependency test with the evidence of cross-sectional dependence among the variables given the statistical significance of the CD statistics. From the table, we conveniently fail to accept the null hypothesis of

Table 2. Summary statistics.

	CO_2	Y	Y^2	T	O	F	I
Mean	13.578	6.486	5.707	22.980	3.775	4.326	2.992
Median	13.105	7.724	5.966	22.975	3.873	4.424	3.000
Maximum	16.153	1.406	1.980	24.668	4.566	4.525	3.620
Minimum	12.055	6.746	4.551	20.427	2.749	3.938	2.230
Std. Dev.	1.083	3.886	5.027	0.854	0.351	0.186	0.359
Skewness	0.774	−0.095	0.481	−0.233	−0.944	−0.529	−0.335
Kurtosis	2.627	1.577	2.257	2.990	3.313	1.724	2.855
Jarque-Bera	16.279	13.219	9.477	1.403	23.516	17.626	3.028
Probability	0.000	0.001	0.008	0.495	0.000	0.000	0.219
Observations	154	154	154	154	154	154	154

Source: Author's computation.

Table 3. Correlation matrix.

	CO_2	Y	T	O	F	I
CO_2	1					
***p*-value**	–					
Y	−0.367***	1				
***p*-value**	(0.0000)	–				
T	0.495***	0.110	1			
***p*-value**	(0.0000)	(0.1739)	–			
O	0.108	−0.055	0.524***	1		
***p*-value**	(0.1804)	(0.4905)	(0.0000)	–		
F	0.329***	0.272***	0.652***	0.639***	1	
***p*-value**	(0.0000)	(0.0006)	(0.0000)	(0.0000)	–	
I	0.163**	−0.240***	0.478***	−0.038	−0.152*	1
***p*-value**	(0.0429)	(0.0027)	(0.0000)	(0.6333)	(0.0595)	–

Note: ***, ** and * are 1%, 5% and 10% significance level, respectively.

cross-sectional independence at a 5%significance level. The presence of cross-sectional dependence implies that the use of first-generation panel root tests would be misleading and spurious given that it is based on the assumption of cross-sectional independence. Consequently, the second-generation panel estimation of the unit-root technique is adopted to capture and account for cross-sectional dependence (Table 4).

Table 5 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, rather augmenting it to include the lagged cross-sectional mean and its first difference is necessary and sufficient to capture the cross-sectional dependence that arises through a single-factor model. We observe from Table 5 that income squared (under the CIPS panel) is the only variable that is significant at the level at 10% level of significance. However, the rest of the variables in both methods of the unit root test are significant at the first difference at 1% and 5% levels of significance accordingly. The results reported in Table 5 support the presence of unit root in all the variables listed under review.

Table 6 reports the error-correction-based panel cointegration tests as proposed by Westerlund (2007). Westerlund cointegration test is a robust cointegration procedure that accounts for cross-sectional dependence with four normally distributed tests, namely, $G\tau$, $G\alpha$, $P\tau$, and $P\alpha$. The assumption of unit-specific error correction parameters is the basis upon which the first two tests are premised; as such, they are mean-group tests, while the latter tests are premeditated on the assumption of common error-correction parameter across cross-section units. These tests account for cross-section unit-specific trend and slope parameters as well as the cross-section unit-specific short-run

Table 4. Cross-sectional dependency (CD) test results.

Model	Pesaran CD Test	*p*-value	Pesaran LM Test	*p*-value
CO_2	18.864***	(0.0000)	51.247***	(0.0000)
Y	19.534***	(0.0000)	54.955***	(0.0000)
T	18.544***	(0.0000)	49.438***	(0.0000)
O	1.7997***	(0.0000)	13.239***	(0.0000)
F	4.3183***	(0.0000)	33.983***	(0.0000)
I	13.890***	(0.0000)	28.086***	(0.0000)

Note: *** is 1% significance level.

Table 5. Panel IPS and CIPS unit root test.

	CIPS				IPS			
	I (0)		I (1)		I (0)		I (1)	
Variables	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***
T	−1.623	−1.601	−4.256***	−4.780***	−1.087	−1.372	−4.329***	−4.959***
O	−1.847	−2.109	−3.864***	−3.850***	−1.578	−1.824	−4.262***	−4.555***
F	−1.733	−2.197	−4.004***	−4.008***	−1.336	−2.620	−5.346***	−5.293***
I	−1.373	−1.380	−2.892***	−2.962**	−1.238	−2.261	−3.302***	−3.305***

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

dynamics. The results obtained from Westerlund's test are robust and consistent. All the test results confirm the panel cointegration at 1% and 10% level of significance. This evidence supports the presence of a long-run relationship between carbon dioxide emissions, income per capita and the square of income per capita, tourist arrivals, trade, fossil fuel, and institutional quality across the seven (E7) economies. Hence, the impact of income per capita and its square, tourist arrivals, trade, fossil fuel energy consumption, and institutional quality on carbon dioxide emissions for E7 economies over the period 1995–2016.

Estimation of EKC

Table 7 reports the result of the empirical regression model, and the outcome of this model is consistent with other empirical evidence archived in the literature; however, the level of significance differs. Given the results of panel cointegration with the presence of long-run relationships between carbon dioxide emissions and its determinants, we proceed, therefore, to investigate by estimating the long-run coefficients. The methodologies employed are unique and capable of ensuring robust results. The results of the techniques employed are reported in Table 7. From our empirical results (Table 7), we observe a positive and negative sign for income per capita and the square of income per capita along with statistical significance at 5%and 10% accordingly across the different techniques employed. This is an indication of an inverse U-shaped relationship between these 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 supports the EKC hypothesis.

This study affirms the EKC hypothesis by the seven economies (E7). It is interesting to observe that tourist arrival has a significant and positive effect on carbon dioxide across

Table 6. Westerlund (2007) cointegration test.

Statistics	Value	*p*-value
$G\tau$	−1.520*	(0.061)
$G\alpha$	−2.251***	(0.000)
$P\tau$	−3.972*	(0.095)
$P\alpha$	−1.543*	(0.085)

Note: *** and * are 1% and 10% significance level, respectively

Table 7. AMG, CCEMG and Driscoll-Kraay result.

Variables	AMG	CCEMG	Driscoll-Kraay
Y	0.003**	0.002**	0.001*
p-value	(0.048)	(0.036)	(0.095)
Y^2	−7.750*	−1.270*	−7.510**
p-value	(0.062)	(0.074)	(0.047)
T	0.049***	0.143*	1.291***
p-value	(0.003)	(0.086)	(0.000)
O	−0.021**	−0.001*	−1.772***
p-value	(0.045)	(0.080)	(0.000)
F	1.707***	1.279***	0.715***
p-value	(0.004)	(0.005)	(0.005)
I	−0.024*	−0.015*	−1.386***
p-value	(0.062)	(0.093)	(0.000)
Wald test	20.50**	12.46*	272.75***
p-value	(0.0023)	(0.0524)	(0.0000)
No. Regressors	6	6	6
No. Observations	154	154	154
No. Group	7	7	7
R^2			0.6498

Note: ***, ** and * are 1%, 5% and 10% significance level, respectively.

the E7 panel countries. This implies that environmental quality is threatened with an increase in tourist arrivals, hence degrading the environment. On the other hand, trade is seen with a significant and negative effect on carbon dioxide emissions. Implying that the summation of exports and imports across the E7 increases environmental quality and, by extension, sustainability. Fossil fuel energy consumption is reported to have a positive and significant effect on carbon dioxide emissions. This suggests that fossil fuel increases environmental degradation in the E7 economies. Unlike the institutional quality, it is observed to be significant and inversely related to carbon dioxide emissions across the panel countries under review. The implication of this is that an increase in institutional quality reduces environmental degradation within the panel of countries under review. In general, we can observe that the effects of the results for E7 economies reveal the existence of an inverted U-shaped relationship between Y, Y^2, T, O, F, and I, hence validating the EKC hypothesis for the E7 economies.

Table 8 reports the result of pairwise Dumitrescu and Hurlin panel Granger causality tests. This investigation is necessary to ascertain the Granger non-causality from each independent variable to carbon dioxide emissions in a heterogeneous panel framework.

Table 8. Causality analysis.

Null Hypothesis:	F-Statistic	*p*-value	Causal remarks
$Y \rightarrow CO_2$	5.958**	(0.0159)	Feedback
$CO_2 \rightarrow Y$	4.206**	(0.0421)	
$Y^2 \rightarrow CO_2$	5.533**	(0.0200)	One-way
$CO_2 \rightarrow Y^2$	0.223	(0.6373)	
$T \rightarrow CO_2$	0.000	(0.9871)	No-causality
$CO_2 \rightarrow T$	1.158	(0.2836)	
$O \rightarrow CO_2$	0.002	(0.9636)	No-causality
$CO_2 \rightarrow O$	0.096	(0.7567)	
$F \rightarrow CO_2$	2.051	(0.1543)	No-causality
$CO_2 \rightarrow F$	0.978	(0.3243)	
$I \rightarrow CO_2$	4.459**	(0.0364)	One-way
$CO_2 \rightarrow I$	0.049	(0.8239)	

Note: ***, ** and * are 1%, 5% and 10% significance level, respectively, while → denote does not 'Granger cause'.

We find a feedback causality between income per capita and CO_2 emissions. This implies that economic activities that translate to income per capita do aggravate the depletion of the environment with excess carbon dioxide emissions and this form of relationship is also seen from CO_2 to income per capita. This trajectory is expected for most economies at the initial stage of their development. In the case of squared of income per capita, a one-way causality is established to CO_2 emissions with a 5% level of significance. This finding is suggestive and insightful to stakeholders in the E7 economies.

Measures should be sought to consolidate on the negative effect of the squared of income on CO_2 emissions. This implies that the environment is not degraded at the expense of economic growth, rather, deliberate efforts are seen by authorities to maintain a clean and quality environment. Tourist arrivals from Table 8 have no causality with CO_2. This implies that tourist arrival has no causal interaction with environmental degradation. This suggests that tourism-induced EKC is not valid among the E7 panel of economies.

Granger causality

The estimates from the combined panel estimators that are applied in the study may not necessarily reflect the direction of causality among the variables, thus, we provide a causality test report for the variables in the present study following the importance of this test in various empirical studies (Amiri & Ventelou, 2012; Alola & Kirikkaleli, 2019; Gyamfi et al., 2021a, 2021b, 2021c; Onifade et al., 2020). We report the Dumitrescu and Hurlin (2012) Granger causality test for the study.

$$Y_{it} = \delta_i + \sum_{k=1}^{p} \beta_{1ik} Y_{i,t-k} + \sum_{k=1}^{p} \beta_{2ik} X_{i,t-k} + \varepsilon_{it} \tag{3}$$

From Equation (3), β_{2ik} and β_{1ik} denote the regression coefficients and the autoregressive parameters for individual panel variable i at time t, respectively. Following the assumption of a balanced panel of observation for the variable Y_{it} and X_{it} in the study, the null hypothesis of absence of causality among variables was tested against the alternative hypothesis of heterogeneous causality in the panel observation. The Granger causality results are provided in Table 8 while an annotated diagrammatical representation of the overall empirical scheme, based on the adopted econometric outcomes, is detailed in Table 1.

However, no Granger causality was seen between trade and CO_2 emissions as well as fossil fuel and CO_2 emissions. Implying that fossil fuel energy consumption and trade lack the interactive and causal relationship to deplete the environment as ordinarily would have been expected in the E7 economies. This finding is intuitive and indicative to policymakers and environmental economists in the E7 economies, especially as it is well-established in energy literature that non-renewable energy sources are major sources of environmental degradation. Lastly, a one-way causality is observed from institutional quality to CO_2 emissions at a 5% level of significance. This suggests that strong institutions could influence and affect the environmental quality of the E7 panel economies.

Conclusion and direction for future research

Given the significant progress in the expansion of economic growth of the **E7 countries, and using tourist arrivals,** trade, carbon dioxide emissions, non-renewable energy, and institutional quality as determinants, this study explores tourism-CO_2 emissions-economic growth causality as well as accounting for the role of institutional quality. Furthermore, the effect of these variables on environmental performance is also taken into consideration vis-à-vis the role of institutional quality in **ensuring a cleaner and more friendly environment** among the E7 countries. Also, interest in establishing Environmental Kuznet Curve (EKC) among the E7 countries and the implications, especially with regard to policy direction, was explored. **The contribution of o**ur study to the tourism literature is the inclusion of institutional quality and macroeconomic variables to the mix. The inclusion of the additional variables into the econometrics setting is worthwhile to circumvent for omitted variable bias. **Second generation** panel estimation techniques, in conjunction with the Driscoll-Kraay robust estimator, have been employed to accommodate for cross-sectional dependency in the panel under review, as well as for robustness of coefficients and estimates. The empirical results affirm the presence of the EKC phenomenon and tourism-induced emission in E7 economies, thereby suggesting that sustainable tourism has a deteriorating impact on the outlined industrialised countries **examined as the emphasis is on** increased income level via the channel of sustainable tourism at the expense of environmental quality. Similarly, GDP growth and non-renewable energy also dampen the quality of the **environment, as shown by the robust r**egression of AMG and CCEMG, in that an increase in non-renewable energy and tourism demand increases CO_2 emission in E7 economies.

The tourism literature has documented studies on the Tourism-led Sustainable Development Hypothesis (TLSD) where tourism development is seen as a catalyst for economic expansion. However, there exist other dimensions of tourism development left unexplored, some of which our study seeks to address. Over the years, extant literature provides evidence **of the twin growth phenomenon** between energy and tourism, thereby suggesting that tourism development activities spur increased energy demand. **This study extends** the extant literature by considering other covariates to offer a new perspective to the tourism-led sustainable development debate for E7 industrialised economies.

The key conclusion from this study is that tourism development induces CO_2 emission in E7 economies. The plausible explanation is attributed to the economic structure **of these economies, where t**he focus is on GDP growth with little or no emphasis on the quality of the environment. This outcome also gives credence to the EKC phenomenon. These outcomes are resonated by both regression and causality analysis. **The take-home of this study** s**tretches to the enforcement of more sustainable tourism activities that are driven by** green energy **and ecosystem friendly.** Additionally, given the twin growth observed between non-renewable energy and tourism development, which trigger environmental degradation, this revelation is insightful as there is need for a change of the energy mix which drives CO_2 emission to renewables and cleaner technologies, and possibly to enact regulation(s) such as polluters pay principles and being active committed members to environmental treaties. This recommendation is in line with the United Nations sustainable development goals (UN-SDGs-7, 8, 12 and 13)**, which** address issues around sustainable and responsible energy consumption for sustainable economic development, which includes sustainable tourism.

The present study explores the role of institutional quality, trade flows and non-renewable energy consumption in the **tourism-led** Sustainable Development Hypothesis (TLSD) framework in E7 economies. The consumption of non-renewable energy and tourism development have been the major drivers of economic growth in the region under consideration and were observed to have an **adverse effect** on the environment. However, there is a consensus on the debate and, as such, there is room for an extension by other researchers to advance the frontier of knowledge in the extant literature by considering other covariates, such as demographic variables like population, as well as economic globalisation, using disaggregated data for other emerging blocs such as sub-Saharan Africa.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Appendix

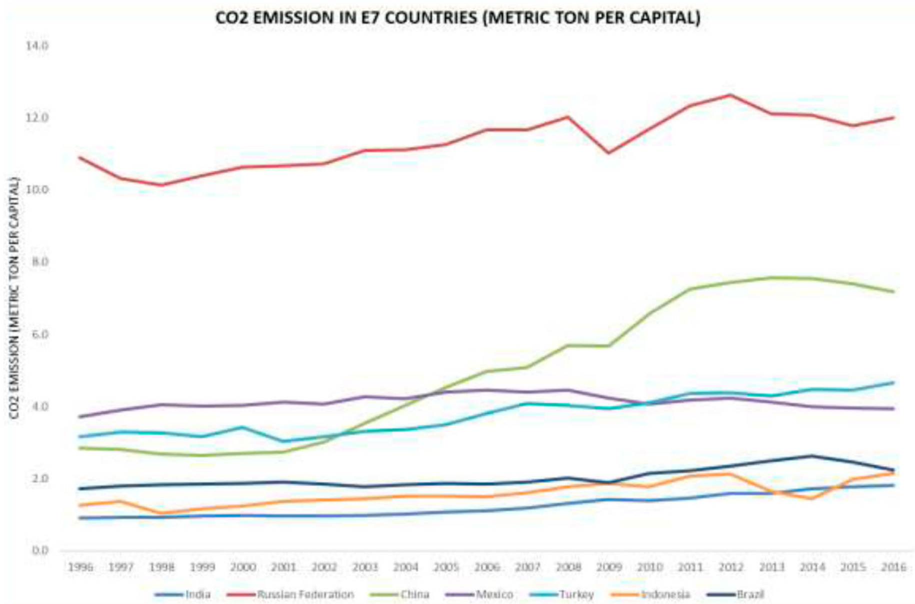

Figure A1. CO_2 emission in E7 countries.