Institutions and Economies
Vol. 17, No. 3, July 2025, pp. 107-129 https://doi.org/10.22452/IJIE.vol17no3.5

Impact of Tourism and Economic Growth on Air Pollution in Developing Countries

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Abstract: *Tourism development has frequently been regarded as a growth pillar in recent times, owing to its significant contribution to socioeconomic development and the expansion of tourism-led economies. Expansion of the tourism industry and more economic development could, however, come at the expense of environmental damage. The purpose of this study is to determine the influence of tourism, economic growth, and environmental pollution in a panel of 35 developing nations from 1995 to 2018 using a generalised method of moments (GMM) estimator. According to the findings, rising tourist numbers in developing nations are linked to greater levels of particulate matter 2.5 ($PM_{2.5}$) and carbon dioxide (CO_2), while economic expansion has a positive impact on the environment. For the panel of countries under consideration, there are non-linear relationships between economic growth and air pollution that follow a U-shaped pattern. The result also reveals that economic growth plays a significant moderating role in reducing the environmental effects of tourism. The finding demonstrates that to ensure long-term economic growth and development, wise public policies should be implemented that prioritise environmental sustainability. Host governments should work to support environmentally and socially responsible tourism sectors in their nations.*

Keywords: Air pollution; Developing countries; Economic growth, System generalised method of moments (GMM); Tourism
JEL Classification: O44, Z32, Q53

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1. Introduction

Tourism makes a significant contribution to the economic growth of host countries. Tourism is one of the industries with the quickest growth rates, according to Freitas (2017), and acts as a macroeconomic engine for expansion and progress. Globally, many developing countries rely heavily on tourist expenditure, which contributes significantly to their gross domestic product (GDP). According to Zeng et al. (2021), tourism accounts for over 40% of the GDP of developing countries and 70% of the GDP of extremely small island nations. Additionally, the World Tourism and Travel Council (WTTC) estimates that 1.2 billion people travelled abroad in 2015. As a result, the tourism sector contributed USD7.2 trillion, or 9.8% of the world's GDP, and generated 284 million employment opportunities, or 9.5% of all employment opportunities worldwide. These statistics demonstrate the growing contribution of tourism to the world economy.

Tourism contributes to the growth and development of a country, mainly through drawing in a variety of economic advantages and positive impacts and by fostering the development of local brand value, identity, and image (Naseem, 2021). The tourism sector contributes significantly to economic growth in ways that go beyond just offering appealing travel locations. It has a significant impact on strengthening a country's economy. By drawing visitors from abroad, tourism helps to provide foreign exchange benefits that support the nation's sustained economic growth by creating jobs, improving infrastructure, and improving quality of life. Sales, earnings, salaries, tax income, and exports all increase when more people visit the area (Calero & Turner, 2020). A review of the literature indicates that the development of tourism, along with capital, agriculture, and energy, supports growth in the majority of developing countries (Khan et al., 2020; Wang & Ma, 2015).

Tourism has a favourable contribution to growth in revenue, opportunities for employment, earnings, and output; however, it can also harm the environment due to factors such as traffic congestion, pollution, and ecological degradation (Ren et al., 2019). There have been claims that the tourism industry can harm the environment, for example, by causing air and water pollution. Due to the emissions of greenhouse gases, the tourism business has been labelled as environmentally harmful (Higham et al., 2016). Zaman et al. (2016) examines the association between tourism growth and carbon dioxide (CO_2) emissions in developing and developed

nations between 2005 and 2013 and conclude that tourism might increase emissions of CO_2. National and tourist emissions have also been examined by Rico et al. (2019), who conclude that the global tourism industry will overtake other industries as the fifth biggest polluter in the world. Tourism-related emissions are predicted to double from their 2005 level by 2035. It is widely recognised that unless considerable initiatives are undertaken to foster socioeconomically viable and environmentally sustainable tourism worldwide, the positive aspects of tourism will be significantly overwhelmed by the negative aspects.

Additionally, the effects of diverse economic activities and the advantages of economic expansion frequently have a negative impact on sustaining environmental quality. Future tourist development will be hampered and harmed by economic growth and development driven by tourism at the expense of environmental pollution and deterioration. As a result, countries frequently have to choose between environmental conservation and economic growth. However, this does not imply that economic growth is necessarily detrimental to the environment. Higher development can broaden the range of options, for example, by inventing new, cleaner methods of generating energy. The relationship between real income, energy use, carbon emissions, and tourism was examined by Dogan and Aslan (2017), who find that the growth of the tourism industry could lower CO_2 emissions. Gamage et al. (2017) examine how Sri Lanka's energy use and tourism receipts influenced CO_2 emissions between 1974 and 2013, concluding that tourism receipts reduced emissions. Economic prosperity can also increase people's willingness to forego a portion of their income to achieve a cleaner environment. No one seeks to maximise their economic prosperity alone, and as people rise in social standing, they can prioritise the environment without compromising their ability to meet their basic requirements.

This study expands on the premise that tourism expansion and economic acceleration among developing countries could significantly affect the environmental situation. Multiple environmental pollution factors, including air pollution that cause high temperature swings and rainfall events, are already linked to climate change. In this case, it is important to look into the connection between tourism, economic growth, and environmental pollution in developing countries. The results are anticipated to direct the creation of advantageous public policies to boost the environmentally friendly tourism

sector in the selected countries. As a result, it will promote regional social welfare, economic growth, and development.

The rest of the study is divided into the following sections. The related literature on trade openness and pollutant emissions is presented in Section 2. The methodology is described in Section 3. Section 4 empirically examines the influence of trade openness on the environment and its moderating effect. Conclusions and policy implications are presented in Section 5.

2. Literature Review

Environmental pollutants have been correlated with economic growth, which can be understood from the theory of the environmental Kuznets curve (EKC). Grossman and Krueger (1991) state that environmental quality tends to deteriorate during the early phases of economic development. However, environmental quality improves after an economy reaches an income threshold. As the economy grows beyond a predetermined point, it strives to enhance technology to reduce emissions. Thus, the EKC hypothesises an inverse U-shaped relationship between environmental emissions and economic growth. According to the EKC hypothesis, environmental emissions are predicted to correlate positively with income growth prior to the inflection point of the EKC and negatively with income growth thereafter. However, the relationships between economic growth and environmental emissions have captured much attention over the past decades, with mixed empirical findings.

A wide range of studies have already confirmed the EKC hypothesis (e.g., Danish et al., 2017; Haseeb et al., 2018; Hafeez et al., 2018; Liu, Kim, & Choe, 2019). Shahbaz et al. (2015) report that CO_2 emissions have a positive and statistically significant impact on GDP per capita and support the presence of EKC in selected African countries. According to Rofiuddin et al. (2019), higher per capita GDP and population cause environmental degradation in low-income economies, while energy consumption has no effect. The outcome supports the EKC theory in low-income economies. Industrial emissions of sulfur dioxide (SO_2) and soot have an inverse U-shaped association with per capita GDP, and the rise in SO_2 emissions has been a major factor impeding China's economic progress (Wang et al., 2021). Cetin et al. (2018) document that economic acceleration, energy

utilisation, financial progress, and trade openness are the key factors that influence environmental emissions. Similarly, Zameer et al. (2020) find that trade openness, energy use, and economic growth positively reinforce CO_2 emissions.

Others, however, reflect a U-shaped association that is not in accordance with the EKC hypothesis (Chang, 2015; Mert & Bölük, 2016; Saidi & Mbarek, 2017; Liu & Bae, 2018; Vo & Le, 2019). Georgiev and Mihaylo (2015) reveal that the EKC inverted U-shaped association of income and pollution does not exist across all OECD countries' local and global air pollutants. Aung et al. (2018) also report no evidence to support the EKC theory for CO_2 in Myanmar due to the positive short-term and long-term connection between CO_2 and GDP. Because there is a long-term positive correlation between economic growth and emissions (CO_2 and CH_4), the EKC hypothesis is not validated (Islam et al., 2022). Massagony and Budiono (2022) discover that the EKC hypothesis does not hold for CO_2 emissions in Indonesia since, in the long run, the model predicts that CO_2 emissions will rise in tandem with income.

On the other hand, the EKC hypothesis is supported by Shahbaz and Sinha (2019), Purcel (2020), and Klavuz and Doan (2020), who emphasise that both economic growth and industry might have a substantial impact on environmental emissions. Tourism may serve as a growth engine, boosting GDP growth, employment creation, and foreign exchange generation (Alhowaish, 2016). Economic growth also benefits tourism development by promoting infrastructure and services, as well as the advancement of transportation and information and communication technology. In this context, several studies, such as those by Manzoor et al. (2019), Songling et al. (2019) and Naseem (2021), examine the relationship between tourism and economic growth utilising the Granger causality test on time-series data analysis. The tourism-led growth notion is supported by these studies.

According to Shahbaz et al. (2015), nations that overly pursue tourism development objectives would incur additional expenditures for their environmental effects and contribution to climate change. Many studies demonstrate that the growth of the tourism industry would have negative environmental consequences, even though it is crucial for job creation and economic development (Saenz-de-Miera & Rossello, 2014; Azam et al., 2018). Compared to other service industries, the tourism sector has more negative environmental effects, especially on air quality (Hsieh et al., 2013).

This is because an increase in tourism-related activities results in a higher demand for energy from a range of resources, notably housing, infrastructure building, tourist destinations, and air and land transportation (Nosheen et al., 2021; Zeng et al., 2021). Each of these highly energy-intensive operations has a negative impact on the environment in all countries, producing different air pollutants that are an inevitable consequence of tourism operations, making the industry one of the main drivers of climate change (Shaheen et al., 2019; Ren et al., 2019; Bella, 2018).

Wang and Wang (2018) state that growth in tourism would raise environmental degradation, and higher CO_2 emissions would have a laggard and detrimental effect on tourism development. Similarly, Shakouri et al. (2017) report that growth in tourism increases CO_2 emissions. Sun and Liu (2020) provide evidence that the shift in slope trends of the overall pollution index, tourist numbers, tourism economic output, and tourism waste were all increasing in the West Lake Basin in Hangzhou, China. The government promoted tourism's economic benefits independently while ignoring the environmental damage that tourism generated, which caused this spike in water contamination in the basin. Ciarlantini et al. (2022) examine the connection between regional air pollution and tourism expansion in five popular tourist locations in Europe (France, Spain, Greece, Portugal, and Italy), with the results showing that none of these countries support the tourism induced EKC theory. Additionally, there are discrepancies between the effects of domestic and international tourists on air pollution, with domestic tourists increasing emissions and international tourists having a negative impact.

Weaver (2011) argues that the development of ecotourism and sustainable tourism does not always increase CO_2 emissions but may even decrease them. Zaman et al. (2016) also reports that tourism sector development should not be at the cost of environmental degradation. Tourism growth may result in a reduction in carbon emissions (Ahmad & Ma, 2021). Multiple mediating effect analyses' findings suggest that the tourism industry can reduce carbon emissions by doing two things: substituting low-emission sectors and encouraging the use of renewable energy. According to the empirical findings of Azam et al. (2018), tourism significantly reduces environmental pollution in Malaysia. However, Thailand and Singapore have found a negative correlation between tourism and environmental damage. Sun et al. (2019) also find no significant effect of domestic travel on environmental degradation in China. Paramati et al. (2017) states that the influence of tourism

on CO_2 emissions is decreasing significantly faster in developed economies than in developing economies, as supported by the EKC theory.

Tribe (2016) and Fletcher et al. (2017) find that the presence of economic and tourism engagement will likely have an impact on the environment. According to Suresh and Tiwari (2018), the relationship between tourism and economic growth changes throughout time and over various time horizons. Regarding research on tourism and CO_2 emissions in China, Zhang and Gao (2016) look at how pollution, energy use, economic growth, and international travel are related in 30 Chinese regions between 1995 and 2011. They claim that by lowering CO_2 emissions in Eastern China, the growth of the tourism industry helps to mitigate environmental damage. This might be because Eastern China has produced several technological advancements and green hotel programmes. Progressive economic growth will aid in securing better outcomes from tourism activities while having the least adverse influence on the environment and resource usage due to technological advancements that lead to greater energy efficiency (Fletcher et al., 2017; Zha et al., 2020). Furthermore, as increasing income growth causes society to recognise the presence of an environmental pollution issue, national governments may establish applicable environmental legislation.

Even though past research has made tremendous efforts to concentrate on environmental concerns, there are still large gaps in the literature. For instance, the moderating effect of tourism on the environment in developing countries has not been extensively studied. Although tourism can bring economic benefits as well as encourage the development of developing countries, it can also have a harmful impact on the environment. As a result, it becomes necessary to evaluate the connections between tourism, economic acceleration, and the environment to create effective policies that would allow developing countries to flourish while preserving the environment.

3. Research Methodology

The study sample data includes 35 developing countries within middle-income countries from 1995 to 2018. Many developing nations rely heavily on tourist spending, which significantly boosts the GDP and drives productivity growth. Data sources were drawn from the World Development Indicators (WDI), and definitions are provided in Table 1.

Table 1: Summary of Data

Variables	Definition	Unit measurement	Source
$PM_{2.5}$	Emissions of $PM_{2.5}$	Country level, $PM_{2.5}$ (micrograms per cubic metre)	WDI
CO_2	Emissions of CO_2	CO_2 (metric tons per capita)	WDI
Y	Real GDP per capita	Constant 2015 US dollars	WDI
TO	Trade openness	Total trade of goods and services (% of GDP)	WDI
TA	Tourist arrival	Total number of tourist arrivals in the host country per year	WDI

To study the impact of economic growth on environmental emissions, this study employed a panel regression equation as follows:

$$lEN_{i,t} = \alpha_0 + \alpha_1 lEN_{i,t-1} + \alpha_2 lY_{i,t} + \alpha_3 lY_{i,t}^2 + \mu_i + \varepsilon_{i,t} \quad (1)$$

where *lEN* is the dependent variable that measures environmental pollution, indicated by the total measurement of air pollution levels, namely the levels of $PM_{2.5}$ ($lPM_{2.5}$) and CO_2 emission per capita (lCO_2). $PM_{2.5}$ represents a measure of the local air pollutant. In contrast, CO_2 represents a global pollutant from burning fossil fuels produced during the consumption of solid, liquid, and gas fuels and gas flaring. *lY* is the real GDP per capita. Following Kang et al. (2016) and Zugravu-Soilita (2018), this variable is included to capture the income effect on air pollution emissions in developing countries, as efforts to increase income often come with increased pollution. On the contrary, the willingness to pay for environmental quality rises as income rises. Then, square GDP per capita was used to analyse the inverted U-shaped relationship between economic growth and environmental degradation using the existing theoretical framework of the EKC model (Lean & Smyth, 2010; Pao & Tsai, 2011). The EKC theory predicts an inverted U-shaped relationship between real income and environmental degradation (Acaravci & Ozturk, 2010). μ denotes country-specific effects, and ε represents an error term assumed to be IID with a zero mean and constant variance. The subscripts *i* and *t* represent cross-sectional countries and time (year).

The development of tourism may have an impact on environmental degradation through the movement of tourists (El Menyari, 2021).

Bella (2018) concurs that mass tourism has been shown to degrade the environment. Nevertheless, the creation of environmentally friendly tourism can easily aid in preserving natural resources. In this circumstance, the EKC model's incorporation of the tourist arrivals variable enables the measurement of the effect of visitor flows on environmental pollution. Regarding that, the increasing total number of tourist arrivals was incorporated into the traditional EKC model by Grossman and Krueger (1991), Gao et al. (2019), and Katircioglu et al. (2014). Thus, the following equation can be suggested in this study:

$$lEN_{i,t} = \alpha_0 + \alpha_1 lEN_{i,t-1} + \alpha_2 lY_{i,t} + \alpha_3 lY_{i,t}^2 + \alpha_4 lTA_{i,t} + \alpha_5 lTO_{i,t} \qquad (2)$$

where *lTA* is tourist arrival measured by the total number of tourist arrivals in the host country per year (El Menyari, 2021; Sharif et al., 2017). In addition, trade openness (*lTO*) is the control variable measured by the ratio of total trade to GDP. The share of trade flows in GDP has been favoured in previous studies in the growing environmental impact study (e.g., Frankel & Rose, 2005; Hakimi & Hamdi, 2015; Ozatac et al., 2017).

Regarding the direct effects and theoretical literature reviewed above, tourism (tourist arrival) and economic growth (per capita income) can indirectly impact environmental pollution. According to Lee and Syah (2018), there is a long-term equilibrium association connecting tourism, economic growth, and pollution. Specifically, they argue that while tourism growth will boost the economy, it will also eventually cause environmental deterioration. Kreishan (2015) reveals that tourism contributed positively to Bahrain's economic growth and proposes that the government might significantly improve its sustainable economic advancement by strategically strengthening the tourism sector. This necessitates the inclusion of sustainable development principles in tourism development strategies. In this sense, higher income suggests that green economic growth is feasible if adequate environmental protection policies are adopted to reduce the adverse impact of specific economic activity sectors linked with the tourism industry on environmental quality (Adedoyin et al., 2021). As income levels rise, people's willingness to pay for environmental quality rises as well, which might strengthen the discussion of the relationship between the environment and the economy and improve decision-making (Yang et al., 2022).

Therefore, from equation (2), the interaction terms of tourism arrival (lTA) and income (lY) are introduced as follows:

$$lEN_{i,t} = \alpha_0 + \alpha_1 lEN_{i,t-1} + \alpha_2 lY_{i,t} + + \alpha_3 Y_{i,t}^2 + \alpha_4 lTA_{i,t} + \alpha_5 lTO_{i,t} + \alpha_6 (TA_{i,t} * lY_{i,t}) + \mu_i + \varepsilon_{i,t} \quad (3)$$

The significant coefficient of interaction implies that the acceleration of tourism and economic growth may positively alter the influence on the environment. Thus, the interaction between tourism development and income may pose a negative sign when a country's environmental pollution level increases.

The generalised method of moments (GMM) estimator was used due to its ability to eliminate time-invariant country characteristics (fixed effects), such as geography and demography, which may have an association with the explanatory variables by conducting the first differences (Badamassi et al., 2017). Since some of the explanatory factors may be endogenous, the GMM limits the simultaneity bias. Since causality occurs in both directions, the explanatory variables may be connected to the error term (Frankel & Rose, 2005). Arellano and Bond (1991) propose using instrumental variables to address the regressors' endogeneity problem. The differentiated lagged dependent variables and the endogenous variables could be instrumented accordingly by their lags in levels, while the exogenous variables could be their own instruments. Furthermore, this methodology can be employed in conditions where the number of cross-sectional units (N) surpasses the duration (T). Thus, the GMM model is a better option for panel data analysis than fixed effects or basic OLS since it addresses a wide range of other econometric concerns.

The first-difference GMM and the system GMM are the two types of GMM estimators (Arellano & Bover 1995; Blundell & Bond 1998). System GMM was employed in the present study. The system GMM is superior to the first-difference GMM in cases where the regressors are persistent. It is also less biassed and more accurate. Blundell and Bond (1998) show that the system GMM estimator results in consistent and efficient parameter estimates and has better asymptotic and finite sample properties than the straightforward first-differences GMM estimator. It allows the use of the lagged first differences of dependent and independent variables as

instruments for the level equations. This instrument is commonly referred to as internal because the source is driven by the current econometric model, improving the model's efficacy (Roodman, 2009). As an alternative, one may examine the GMM estimator using their two- and one-step processes. Because appropriate weighting matrices are used, the two-step estimator is significantly more effective than the one-step estimator. Thus, the two-step GMM estimator was used in this investigation since it produces better results.

The Hansen test (1982) is performed to analyse the consistency and validity of the instruments used in the model. It becomes relevant when the number of instruments is greater than the number of endogenous variables in the model. Roodman (2009) asserts that many instruments could make the Hansen test less reliable. Endogenous variables may be overfitted by the instruments, resulting in biased coefficient estimations and a failure to eliminate their endogenous components. Therefore, it is possible to determine if the instruments are correlated with the residuals by using the over-identifying restriction. Additionally, the Hansen test is used to determine whether the instruments seem exogenous and whether the model's null hypothesis and over-identifying criteria are appropriately defined. Furthermore, AR (1) and AR (2) tests for the presence of second-order serial correlation in the residuals can be used to confirm the model's validity. Blundell and Bond (1998) documented that the model is robust when the null of AR (1) is rejected and fails to reject the null of AR (2).

4. Results and Discussion

Table 2 shows the descriptive statistics for the environmental pollution indicators $PM_{2.5}$ and CO_2 along with other variables examined, including real GDP per capita, tourist arrivals, and trade openness. $PM_{2.5}$ levels range from 10.41 in the Marshall Islands to 66.175 in China, with a mean value of 23.419. In terms of minimum and maximum CO_2 emissions per person, the values ranged from 0.642 in Paraguay to 14.166 in Kazakhstan, with a mean value of 3.476. The mean value of tourist arrivals is 1.06e+07, with the minimum and maximum values of 4690 (Marshall Islands) and 1.50e+08 (China). The mean values of real GDP per capita and trade openness are 5359.335 and 81.554, respectively. Argentina (13857.3) and Malaysia (205.539) had the highest levels of real GDP per capita and trade openness,

while Armenia (1088.05) and Brazil had the lowest levels (17.323). Furthermore, the observed variables showed significant variation between and across nations, which supported the use of panel estimating techniques.

Table 2: Descriptive Statistics

Variables	Mean	Std. dev. (within countries)	Std. dev. (between countries)	Overall std. dev.	Min	Max
$PM_{2.5}$ (EN)	23.419	1.586	10.070	10.075	10.410	66.175
CO_2 (EN)	3.476	0.664	2.602	2.655	0.642	14.166
Tourist arrival (TA)	1.06e+07	6656007	2.43e+07	2.49e+07	4690	1.50e+08
Real GDP per capita (Y)	5359.335	1266.811	2259.836	2567.254	1088.050	13857.300
Trade openness (TO)	81.554	11.705	33.862	35.447	17.323	205.539

The system GMM presumptions are verified by the utilisation of the Hansen J-test for overidentifying restrictions and a second-order serial correlation test for the residuals. The results of the diagnostic tests in the Hansen test demonstrate that all the models have *p*-values that are more than 0.05, which means that there is insufficient data at the 5% level to conclude that the assumptions made by valid instruments are incorrect. It shows that the internal instruments in the dynamic model that were estimated using the system GMM technique are valid. In addition, the residuals of the level regressions do not exhibit autocorrelation issues, as indicated by the *p*-value's inability to reject the null of no second-order autocorrelation (AR2). The number of instruments used is also lower than that of the groups used in the analysis, which displays endogenous variables that are not overfit. These diagnostic tests indicated that the GMM estimation findings shown here were reliable. Further, all of the lag dependent variables' coefficients were found to be statistically significant, indicating that every estimated equation was appropriately regarded as a dynamic model.

The relationship between environmental pollution, tourism, and economic growth is examined through three-panel regression models. The empirical results for the relationship among the key variables are summarised in Table 3. The result of the first panel regression model suggests strong evidence that the EKC hypothesis is not valid for the panel of developing countries in the period under study, where $PM_{2.5}$ and GDP do not obtain an inversed U-shaped relationship. It was, however, noted that

there was a significant U-shaped relationship between economic growth and air pollution. LY is negatively and significantly correlated with $PM_{2.5}$ emissions, whereas LY2 is positively and significantly correlated. This suggests that rising GDP will encourage $PM_{2.5}$ emissions in developing nations. In other words, air pollution first decreased and then increased along with the development of the economy.

Table 3: Effects of Tourism and Economic Growth on Environmental Pollution ($PM_{2.5}$)

Dependent variables	**(1) $PM_{2.5}$**	**(2) $PM_{2.5}$**	**(3) $PM_{2.5}$**
Lagged dependent variable	0.974***	0.973***	0.992***
	(11.06)	(69.60)	(42.12)
LY	-0.150***	-0.019***	-0.020**
	(-3.52)	(-4.22)	(-3.03)
LY2	0.004***	0.009***	0.0002***
	(4.79)	(4.12)	(3.53)
TA		0.232*	0.866***
		(2.02)	(7.14)
TO		-0.027**	-0.021***
		(-3.26)	(-3.72)
LTA*LY			-0.015***
			(-3.43)
Group	35	35	35
Instruments	27	33	31
Hansen J-test	0.287	0.215	0.208
AR (1)	0.322	0.061	0.210
AR (2)	0.907	0.139	0.019

Notes: Figures in parentheses are the standard errors for coefficients. ***, ** and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

The positive and substantial tourism coefficient in the second panel regression model (column 2) shows that tourism worsens the environment by increasing $PM_{2.5}$ emissions across countries. According to the estimation model, a 1% rise in tourism results in an increase in $PM_{2.5}$ of 0.232%, which is significant at the 10% significance level. The finding suggests that foreign tourists considerably increase air pollution emissions in the developing world. This shows that tourism, thus, though a pivotal attraction to the economy, simultaneously becomes its destructor. The tourism sector exploits

resources and consumes energy, which raises $PM_{2.5}$ levels connected to air pollution. Liping et al. (2021) found that local emissions are the primary cause of the $PM_{2.5}$ pollutants in Zhangjiajie, indicating that tourism activity is the primary factor of $PM_{2.5}$ in the city. Azam et al. (2018) also found that the inflow of visitors into Malaysia significantly increases energy consumption and CO_2 emissions. It is a practice of modifying the natural environment artificially, which frequently destroys structures, causes loss of biodiversity, harm to ecosystems, and overuse of resources, especially in economies that rely heavily on tourism (Saenz de-Miera & Rossello, 2013; Jones, 2004). In terms of the control variables, a 1% rise in trade openness is shown to reduce $PM_{2.5}$ by 0.027%, demonstrating that it is not the cause of increases in air pollution.

However, in the long run, as the economy's overall strength and people's living conditions improve, fostering the development of the tourism industry unavoidably raises the bar for the quality of the tourism environment (Zeng et al., 2021). Thus, the interaction term between tourism and economic growth is further tested to see the impact on the environment (column 3). After including the moderating variables, the influence of tourism on $PM_{2.5}$ is negatively significant. This result implies that a country's tourist arrivals' income levels are essential for sustainable tourism growth and environmental deterioration prevention. Further, $PM_{2.5}$ emissions will gradually decline as the economy grows, environmental governance capabilities increase, and public expectations for environmental quality rise. Jaz et al. (2023) and Habibi et al. (2018) both state that with tight government environmental control and more public environmental participation, tourism development can overcome the pollution inflection point and become an environmentally beneficial sector.

A robustness test is performed to ensure the reliability of the estimation results (Table 4). The estimation models display the results of replacing $PM_{2.5}$ as the environmental pollutant indicator with CO_2 emission per capita in place of contribution to greenhouse gas emissions. The results show that the economic growth and tourism indicators' coefficients' direction and significance are constant. Similar to this, the fact that most control variable influences are constant contributes to the robustness of the findings. According to the findings, GDP has a negative and significant relationship with CO_2 emissions, but GDP square has a positive and significant relationship with CO_2 emissions (column 1). The notion that CO_2 emissions

rise asymptotically with economic expansion is supported by the results, which show that the EKC hypothesis is invalid in developing countries. Table 4 also shows that tourism positively and significantly fosters carbon emissions in developing countries (column 2). The findings concur with Khan et al. (2019), who find that Hong Kong and Singapore's tourism expansion encourages the growth of CO_2. Zhang and Liu (2019) show that a 1% increase in international tourism increased CO_2 by 0.034% in Northeast Asian countries and 0.251% in Southeast Asian countries. Finally, the fact that the effect of tourism on CO_2 is statistically significant after controlling for moderating variables (column 3) suggests that the growth of the economy may help to promote greener tourism.

Table 4: Effects of Tourism and Economic Growth on Environmental Pollution (CO_2)

Dependent variables	**(1) CO_2**	**(2) CO_2**	**(3) CO_2**
Lagged dependent variable	0.982***	0.861***	0.974***
	(79.86)	(17.54)	(63.52)
LY	-0.012**	-0.013***	-0.001
	(-2.87)	(-3.35)	(-0.54)
LY2	0.011**	0.004***	0.002
	(2.88)	(3.63)	(0.67)
TA		0.386***	0.403***
		(5.40)	(4.69)
TO		0.008	0.002
		(1.25)	(1.32)
LTA*LY			-0.003**
			(-2.66)
Group	35	35	35
Instruments	29	23	28
Hansen J-test	0.176	0.230	0.125
AR (1)	0.079	0.387	0.060
AR (2)	0.241	0.258	0.250

Notes: Figures in parentheses are the standard errors for coefficients. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

5. Conclusion

The purpose of this study was to empirically investigate the influence of tourism on the number of tourist arrivals per year for 34 developing countries from 1995 to 2018, using the panel system GMM estimator. The study explains the significance of tourism's influence on pollution emissions in developing countries as well as the indirect effects of rising tourism on environmental pollution. The empirical results confirmed that tourism expansion has a significant positive influence on increasing $PM_{2.5}$ and CO_2 emissions. Further, this study investigates the effects of tourist arrivals and economic growth on environmental pollution, revealing the significance of moderating effects. In other words, the externalities of tourism, such as increased pollution emissions, can be controlled with the strength of the economy by imposing greater standards for the quality of the tourism environment.

The results emphasised that the development of tourism would generate environmental externalities in developing countries. The unfavourable impact of tourism appears to be alleviated by the interaction of income per capita. In this situation, higher economic growth could be an ideal solution for promoting the tourism sector's sustainability. The study's empirical results point to certain policy considerations for the industry's continued growth and preserving a clean, green environment, which is essential for fostering economic development. It is feasible to develop a viable and sensible economic policy that promotes tourism to benefit both the economy and the environment. Therefore, appropriate public policy should be implemented, and host governments should work to support socially- and ecologically responsible tourism businesses. This will help to ensure sustainable economic growth and development. It is hoped that the government will make a concerted effort towards sustainable growth that prioritises environmental soundness across all industries, including tourism, as the economy grows stronger.

On the other hand, obtaining data for broad environmental and tourism measurements can improve the study's outcome. In this regard, it could be advantageous to develop a single indicator or index that captures the comprehensive standard of the environmental situation in a country. Such an index would be useful for studying a country's environmental issues and could provide more substantial insights into international patterns.

Other tourism indicators, such as average duration of stay, average tourist expenditure per day, and total tourism receipts, could also contribute to useful research findings. Future research should therefore consider these indicators and compare them with the current findings.

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