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ARTICLE

Exploring the *N*-shaped EKC in the top tourist destinations. Empirical evidence from cross-country analysis

Faisal Faisal[1] | **Sami Ur Rahman**[1] | **Awais Khan**[1] | **Adnan Ali**[2,3] | **Mahmoud Abdelkarim Irshaid**[4] | **Muhammad Yusuf Amin**[1]

[1]Institute of Business Studies and Leadership, Faculty of Business and Economics, Abdul Wali Khan University, Mardan, Khyber Pakhtunkhwa, Pakistan

[2]Faculty of Management, Universiti Teknologi Malaysia (UTM), 81310, Skudai, Johor Bahru, Johor, Malaysia

[3]Department of Management Sciences, Shaheed Benazir Bhutto University Sheringal, 18050, Dir Upper, Khyber Pakhtunkhwa, Pakistan

[4]Islamic Banking Department, An-Najah National University, Nablus, Palestine

Correspondence
Faisal Faisal, Institute of Business Studies and Leadership, Faculty of Business and Economics, Abdul Wali Khan University, Mardan, Khyber Pakhtunkhwa, Pakistan.
Email: faisal@awkum.edu.pk

Abstract

Tourism, energy consumption, economic growth, and financial development (FD) have serious consequences on environmental quality, which have gained attention of researchers. This research study attempts to highlight the impact of these variables on carbon dioxide (CO_2) emissions in the Asian top-four tourism countries, namely, Thailand, Singapore, Malaysia and Hong Kong. To achieve these objectives, the study applied Fully Modified Ordinary Least Squares (FMOLS) econometric technique to estimate the long-run relationship, using annual data. Moreover, the study also applied the Dumitrescu–Hurlin panel causality test to identify the direction of the causality. The findings of the study show that energy consumption and trade openness have a negative impact on CO_2 emissions. Moreover, tourism and FDI affect carbon emissions positively. Moreover, the study also validated the *N*-shaped environmental Kuznets curve in these countries, indicating that economic growth positively influences carbon emissions in the early stages. However, in the middle stage, economic growth positively affects CO_2 emissions, while in the later stage, it affects positively. Further, a unidirectional causality has been found from trade, economic growth and tourist arrivals to FD. Furthermore, based on empirical findings, the study suggests various policy implications for the government of the top-four Asian tourist countries.

1 | INTRODUCTION

Greenhouse gases (GHG) are drastically increased due to industrialisation in the world. Carbon dioxide (CO_2) emissions are among the most contributing factors to GHG, which adversely affects the environment and human health (Pervaiz et al., 2021; Rahman et al., 2022). According to the Intergovernmental Panel on Climate Change (IPCC), GHG emissions have climbed to a historical level in the last decade (Zhongming et al., 2021). Considering the serious consequences of CO_2 emissions on environmental degradation have gained serious attention of researchers and policymakers due to their significant contribution to environmental degradation (Jiakui et al. 2023). Research studies have examined the different causes of CO_2 emissions such as tourism (Paramati et al., 2017), energy consumption (Zaidi et al., 2018; Bekhet et al., 2017; Martins et al., 2019), economic growth (Rjoub et al., 2021; Zaidi and Saidi, 2018), foreign direct investment (FDI) and financial development (FD; Shahbaz et al., 2018). Considering the important aspects of tourism development such as providing employment, raising income level and supporting resident services and amenities, it is also considered a rural development (Aman et al., 2019). However, apart from its significant contribution to economic growth, tourism is likely to affect the quality of the environment (Balsalobre-Lorente et al., 2020; Hussain et al., 2017). Therefore, this research study attempts to explore the combined effect of tourism, FDI, FD, economic growth and energy consumption on CO_2 emissions in the Asian top-four tourism countries.

Most countries of the world are experiencing a significant change in climate due to over-reliance on fossil fuel energy sources, which raises GHG (Pandey et al., 2020). Even on the firm level, it is insisted that achieving comprehensive sustainable goals towards climate protection depends on sustainability performance (Li et al., 2022). Thus far, it motivates researchers and policymakers to thoughtfully highlight fossil fuel sources and causes of CO_2 emissions, which increase global warming (Adedoyin et al. 2021). Currently, tourism is one of the fastest-growing sectors and a significant foreign inflow in many countries. It contributes about 10.4% of the world economy (World Travel and Tourism Council, 2019). After energy and chemicals, tourism is the third-largest contributing industry in the world (Rasool et al. 2021). The World Tourism Organisation claims that the tourism sector's contribution was around 10.4% of the world Gross Domestic Product (GDP) with 1.5 billion international tourist movements before the COVID-19 pandemic. However, due to the COVID-19 pandemic, the tourism sector was badly affected with 427 million international tourist movements around the world by 2021, which is 71% below the levels observed in 2019 (UNWTO, 2022a,b).

Tourism impacts (direct and indirect) several economic activities such as transport, hoteling, commerce, and many other industries, significantly increasing climatic changes in the world (Adedoyin et al., 2021; Dogru et al., 2019; Umurzakov et al., 2022). Literature views tourist receipts (especially international tourism) considerably contributing to the polluted environment, which puts the global climate at risk (Gokmenoglu and Eren, 2020). On the other hand, another point of view says that tourism is good for the environment because it helps a country develop ecologically, encourages energy efficiency and new ideas, and so on (IPCC, 2007). Moreover, theoretically, the tourism–growth–energy–CO_2 nexus is supported by the Environmental KuznetsCurve (EKC) hypothesis.

Further, several factors are needed to expand tourism for a better quality of life. FDI is one of the macroeconomic indicators that significantly affect tourism and economic growth (Fauzel, 2020; Mamirkulova et al., 2020). FDI plays a vital role in the tourism industry by providing the necessary funds for infrastructure development (Selvanathan et al., 2012). Despite worsening environmental quality, tourism increases job creation, trade and earnings from foreign exchange. Higher FDI, which gives experience, technology skills and financial health to the host economy, is required to improve tourism in a country. The increase in FDI significantly affects several economic indicators, which help to increase economic development. Thus, FDI causes an increase in tourism in a country, which enhances economic growth (Fauzel, 2020). However, several factors such as FD could affect the efficiency of FDI, which needs to be considered. FDI causes greater economic performance through the channel of FD. In other words, a better financial system of a country allows the host country to benefit from FDI and exploit FDI more efficiently (Sirag et al., 2018). Aibai et al. (2019) reported that FDI plays a significant positive role in the countries' FD with higher institutional quality. Moreover, FDI also promotes a country's financial quality and quantity in terms of financial efficiency, financial access and financial stability.

Theoretically, Schumpeter (1911) endogenous economic theory supports the FDI–FD–economic growth nexus, which describes that higher FD causes higher economic growth. Thus, the higher FDI promotes FD and raises economic growth. The higher economic growth and consumption of energy phenomena induce businesses to use more fossil fuels for higher production, which increases CO_2 emissions. Energy-efficient items are a beneficial sustainable approach to address environmental issues (Geng et al., 2022). Moreover, the increase in CO_2 emissions affects the environment adversely and raises climate change risk (Chen et al., 2016). Rising CO_2 emissions is a significant threat to all countries' climate around the world. Countries are experiencing higher economic growth, which causes to increase in demand for energy consumption. Extensive energy use causes more waste and residues thrown into the environment, potentially causing environmental deterioration. Mostly CO_2 emissions are produced by fossil fuels such as coal (a primary source for the automotive industry), closely tied to development and economic expansion (Muhammad and Khan, 2019). Recently, during the COVID-19 pandemic, unexpectedly there was a global economic downturn that have a detrimental impact on every area of the economy. On the one hand, it reduces international tourism arrival, FDI inflow and other economic activities, but on the other hand, it improves the air quality (Monteiro et al., 2021). The COVID-19 epidemic had adversely affected the business environment and reduced overall economic activities (Yu et al., 2022). Therefore, international tourism arrival and FDI inflow are largely associated with higher economic activities, which increase the demand for energy consumption and hence affect environmental quality.

This study examines the nexus among tourist arrival, FDI, FD, energy prices, economic growth and CO_2 emissions while considering the EKC hypothesis. The study used panel data of high tourist-receipt Asian countries because Asia is the world's most populous continent with 60% of its population, around 4.58 billion people, taking up 30% of its land (World Atlas, 2019). Moreover, the environment is a key concern for tourist economies because they provide the natural resources that are needed to serve tourists and promote tourism. These economies are largely dependent on the tourism industry to encourage faster economic growth because it significantly boosts the GDP and jobs. Although tourism promotes economic development in tourist economies, it could also significantly affect the environment. Moreover, previous studies have examined the tourism impact on the environment (Becken and Simmons, 2002; Gössling, 2002), but they mainly discussed the tourism impact qualitatively. Empirical research studies based on panel data are scarce in the literature related to tourism and CO_2 emissions.

This empirical research study attempts to contribute to the available literature in the following ways. First, the current study investigates the combined impact of tourism, FDI, FD, GDP and energy consumption on CO_2 emissions. Furthermore, the multivariate framework is used to examine the *N*-shaped EKC, using first-generation and second-generation panel techniques. Furthermore, to the best of the authors' knowledge, this study is the first of its sort in a multivariate blend for Thailand, Singapore, Malaysia and Hong Kong, which are regarded as Asian top tourist destinations. The causal results have been unfolded in the other part of the study, and various policy recommendations have been suggested based on the empirical results.

The rest of the research is organised as follows. The relevant literature is highlighted in Section 2. Section 3 discusses data and econometric methods. Section 4 explains the results of the study, and finally the conclusion and policy implications are discussed in Sections 5 and 6, respectively.

2 | LITERATURE REVIEW

Different studies attempt to investigate the dynamic relationships of different variables and their effect on environmental quality. For instance, environmental taxes (Shahzad, 2020), natural resources management (Hussain et al., 2017), green innovation (Jiakui et al., 2023), food security (Zafar et al., 2022), environmental audit (Baalouch et al., 2019). Most of the variables concerning such research studies are trade, tourism, CO_2 emission, GDP, energy consumption, FDI and FD. However, more research is needed to explore whether the relationship is still valid, besides new environment-friendly technological development and environment stability policies. The literature review of the study is classified into the following sections.

2.1 | Tourism, FDI, economic growth and CO_2 emissions

Tourism and FDI have an unavoidable impact on economic, social, religious, sociocultural and environmental factors (Aman et al., 2019). Recently, serious attention has been paid to the relationship and vulnerability of tourism and climate change around the world (Liu et al., 2022a) because it is critical to highlight the determinants of ecological degradation to reduce environmental challenges. Particularly, tourism has a favourable impact on economic development, as it increases employment and income at the cost of the environment. Various empirical research studies highlighted the tourism and environment nexus. For instance, Tomohara (2016) investigated Japan's tourism-led FDI (inflow) hypothesis from 1996 to 2011. Using the Generalized Method of Moments (GMM) approach, the study concluded that enhancement in foreign tourism positively affects FDI (inbound) beyond tourism-associated sectors. The policies regarding tourism promotion and FDI are planned and implemented independently, although the tourism and FDI association is recommended because their guidelines and efforts aim to increase economic growth. Hussain et al. (2017) explored that both tourist activities and domestic garbage from the community harm the ecosystem of the Karakoram National Park. Moreover, Arain et al. (2020) examined the association between tourism and FDI (inflow) in the world's top tourist destination from 1995 to 2017. The study found a positive relationship between tourism and FDI on low and middle quantiles, except in Russia and Mexico. Moreover, the result shows considerable variances across all nations and inbound tourism and FDI quantiles. Yin and Hussain (2021) examined the association between FDI, tourism, economic growth and ecological footprint. The study explored that FDI, tourism and economic growth significantly contributes to ecological footprint and thus reduced environmental quality. On the other hand, Li et al. (2022) investigated the relationship between tourism (cultural tourism) and environmental sustainability, using data from Northern areas (Gilgit-Baltistan). The study identified a significant impact of tourism (cultural) on sustaining environmental quality.

Moreover, concerning FDI, Zhu et al. (2016) revealed a negative impact of FDI and GDP on CO_2 emissions in the panel data of ASEAN-5 countries. The same negative association is supported by To et al. (2019) in emerging Asian markets from 1980 to 2014 by employing Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordainary Least Square (DOLS). The study validates the pollution haven EKC hypothesis in Asian emerging markets. Malik et al. (2020) tested the nexus among FDI, economic growth, oil prices and CO_2 emission in Pakistan, using 1971 to 2014. Employing the Autoregressive Distributed Lag (ARDL) techniques, the study concluded that Pakistan has rare options to attract only environment-friendly FDI, while the FDI inflow increases economic growth and energy consumption in Pakistan, which leads to increased CO_2 emissions. The study results supported the presence of EKC. Thus, it proves that the views about the FDI-economic growth and CO_2 nexus are still unclear and need to be investigated further.

In addition, the literature also insisted on energy consumption in the FDI–tourism–environment nexus. Halliru et al. (2021) checked the association between FDI, economic growth and energy consumption in West African countries. Using Johansen cointegration and quantile regression tests, the study suggests the presence of inverted U-shaped EKC in all quantiles. However, the *N*-shaped association between FDI and CO_2 emissions only exists in the high quantile. This implies that these countries need to sustain environment-friendly FDI inflow in order to reduce environmental degradation. Tourism, FDI, economic growth and CO_2 emissions nexus have different opinions in different regions. FD and energy consumption could influence tourism, and FDI–economic growth nexus, ultimately affecting environmental quality. Tourism's influence on carbon emissions differs across samples, with FDI increasing emissions in wealthy countries, while negatively impacting developing countries. Dogan et al. (2017) concluded that 99% of relevancy over a cross-sectional dependency, stationarity and a long-run relationship exists among vitality utilisation, GDP, the square of GDP, travel industry and exchange rate on CO_2. Moreover, energy consumption and tourism encourage CO_2 emissions. Similarly, Jebli et al. (2019) investigated the dynamic relationship between the travel industry, vitality utilisation, CO_2 emissions (transport), FD, exchange and GDP regarding the world's topmost visited places covered time, 1995–2013. The study identified a bidirectional causality among the variables and concluded that tourism discourages, while economic growth encourages, pollution and carbon emissions.

2.2 | FD, energy consumption and CO_2 emissions

Shahbaz et al. (2011) examine the nexus among FD, economic growth, energy consumption, population and CO_2 emissions in the case of Pakistan, using the data from 1974 to 2009. Using the ARDL testing procedure, the study validates the presence of the EKC hypothesis. However, the study argued that FD could be beneficial to curtail CO_2 emissions by financing renewable energy projects. Saleem et al. (2020) examine the nexus among economic growth, FD, energy consumption and other control variables with CO_2 emissions in selected Asian countries. Using FMOLS testing techniques, the study argued that in the shape of green growth and green finance, efficient energy could mitigate CO_2 emissions.

Similarly, Wang et al. (2020) investigated the linkage among FD, economic growth and CO_2 in N-11 countries. The results revealed that economic growth and FD promote non-renewable energy sources, which lead to increase carbon emissions. However, technological innovation could reduce CO_2 emissions due to advancements in renewable energy sources. Khan et al. (2020) checked the causality between FD, energy consumption and CO_2 emissions in a panel of 192 countries. The study used panel quantile regression analysis and concluded a positive relationship between FD and carbon emissions, while a negative association has been identified between renewable energy usage and carbon emissions. In addition, Iorember et al. (2020) examined EKC and the role of FD in the energy consumption and environmental degradation nexus in Nigeria from 1990 to 2016. Utilising Bayer and Hanck and ARDL tests, the study revealed that renewable energy improves, while FD adversely affects, environmental quality.

Following the same association, recently, Kirikkaleli and Adebayo (2021) aimed to investigate the association between renewable energy consumption, FD and environmental sustainability while employing FMOLS, OLS and Bayer and Hanck's (2013) cointegration test. The study results identified a negative impact of FD, renewable energy consumption on carbon emissions. However, a positive linkage between GDP growth and CO_2 emissions has been identified. The study insisted that policymakers should maintain environmental sustainability by using renewable energy through FD.

3 | METHODOLOGY

3.1 | Econometric modelling

According to the EKC theory (Kuznets, 1955), environmental degradation increases as economic growth raises. However, Grossman and Krueger (1991) identified an inverted U-shaped relationship between economic development and environmental quality, suggesting that as economic expansion reaches a certain point, environmental degradation grows. But after the threshold, environmental degradation starts decreasing. Environmental advancements would eventually take place when economies develop if the EKC has an inverted U shape. As a result, without major changes, humanity may resume its normal course and still attain environmental sustainability (Stern, 2004). Moreover, the *N*-shaped EKC indicates that the original EKC hypothesis might not hold over time. As an alternative, growth in wages over a certain level of wealth might favourably correlate ecological degradation with sustainable development. According to Torras and Boyce (1998), when technological change occurs, the GDP per capita and carbon emissions nexus takes on an *N*-shaped structure. This may be due to a lack of incentives to increase resource production or to lower gains from technological advancement (Alvarez-Herranz and Balsalobre-Lorente, 2015).

Further, several factors, such as tourism, FDI and trade openness, influence economic growth by increasing industrial and business activities. The increase in economic activities leads to consuming more energy and thus affects the environmental quality. Therefore, the study specified a model that estimates these factors' impact on environmental CO_2 emissions. The regression model for the study is the following.

$$CO_2 = \propto_o + \beta_1 FDI_{it} + \beta_2 G_{it} + \beta_3 G_{it}^2 + \beta_4 G_{it}^3 + \beta_5 TRD_{it} + \beta_6 TU_{it} + \beta_7 E_{it} + \beta_8 F_{it} + \varepsilon_{it}. \quad (1)$$

Considering the natural log of variables on both sides, model 1 can be re-written as

$$\begin{gathered} rlnCO_2 = l \propto_o + \beta_1 \ln FDI_{it} + \beta_2 lnG_{it} + \beta_3 lnG_{it}^2 + \beta_4 lnG_{it}^3 + \beta_5 lnTRD_{it} + \beta_6 lnTU_{it} + \beta_7 lnE_{it} \\ l + \beta_8 lnF_{it} + \ \varepsilon_{it}. \end{gathered} \quad (2)$$

CO_2 in the model is a dependent variable, which is a proxy for environmental degradation. The *G*, *FDI*, *TRD*, *TU*, *E* and *FD* represent the GDP per capita, FDI at % of GDP, trade as % of GDP, international tourism measured by the tourist arrivals, energy use and FD proxied with domestic credit to the private sector as % of GDP. This study used data of four Asian countries, namely, Thailand, Singapore, Malaysia and Hong Kong, from 1988 to 2014 and are among the top destinations for attracting a large number of tourist arrivals globally. Further, the data frame is selected based on the availability of the data, and the data are downloaded from the World Bank database. The symbol $\propto_o$ shows the intercept in the graph, β represents the slope and ε represents the error term in the model.

Furthermore, following the research studies of Zhang et al. (2022) the study presented the relationship among the variables in Figure 1.

3.2 | Econometric strategy

3.2.1 | Cross-sectional dependence (CD)

Balance panel data have been used in this study for a panel of high-tourist Asian countries selected for the study. The panel data assume that the variables may have CD among them. Unbiased estimates can be produced if the issue of such dependence among the variables can be avoided. First, checking the

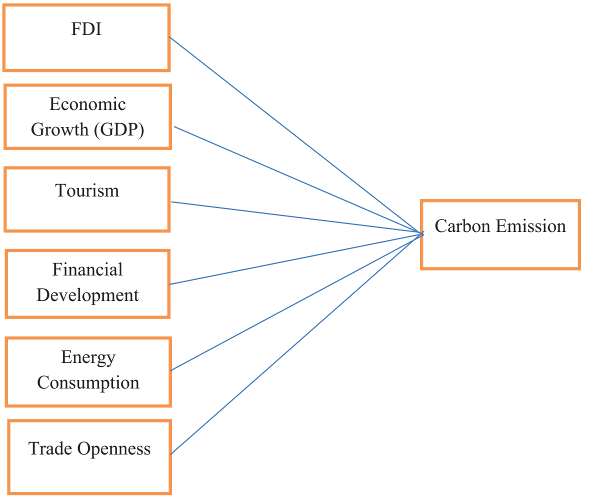

FIGURE 1 Theoretical framework of the study. [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 1 Cross-sectional depency and. Unit root test

Pesaran scaled cross-sectional dependence test		**Breusch and Pagan**	**Pesaran's CADF unit root test**	
Variable	**Pesaran CD**	**Lagrange Multiplier(LM) test**	**L**	**1st Dif.**
lnCO_2	5.7052*	25.7634*	−1.845	−4.719*
ln$E$	5.5912*	25.3687*	−1.972	−2.896**
lnFD	8.0499*	33.8858*	−2.165	−3.803*
ln$G$	27.1095*	99.9100*	−1.279	−3.232*
lnTU	23.9284*	88.8905*	−2.054	−2.615**
lnTRD	10.9247*	43.84440*	−1.063	−2.763**
lnFDI	0.5540	7.9191*	−1.888	−5.549*

*shows significance at 1%.

CD of the variables is important. For this purpose, Pesaran's (2004) proposed CD test, and Breusch and Pagan (1980) will be considered. Results of the test are reported in Table 1, indicating the existence of CD between the variables. The null hypothesis of no CD is rejected at a 1% level of significance. The results show the presence of CD between the primary variables of the study, which are CO_2 emissions (C), energy use (E), FD, GDP (G), tourists' arrival (TU), trade (TRD) and FDI.

3.2.2 | Panel unit root tests

Before implementing long-run estimation methods, it is a key step in econometric estimation to check the stationary level. This study observes several variables; therefore, looking at the order of integration is necessary (Abbasi et al., 2021). As there is a cross-sectional issue among all the variables, applying the unit root test becomes necessary to solve this issue (Abbasi et al., 2021). The significance of the p-value is crucial in deciding the cointegration order (Aqeel et al., 2022; Ge et al., 2022). The second generation of panel unit root tests can be a good choice for our study for combating the CD issues. The Cross-sectionally Augmented Dickey-Fuller (CADF) and Cross-sectionally Augmented

IPS (CIPS) panel unit root tests are selected for the purpose proposed by Pesaran in 2007. As Pesaran (2007) declared, CADF equation can be written as

$$\Delta Y_{it} = \beta_i + a_i y_{i,t-1} + b_i \bar{y}_{t-1} + d_i \Delta \bar{y}_t + \mu_{it}.$$

If a lag is added, the equation will turn into the following:

$$\Delta Y_{it} = \beta_i + a_i y_{i,t-1} + b_i \bar{y}_{t-1} + \sum_{j=0}^{p} d_{ij} \Delta \bar{y}_{t-j} + \sum_{j=1}^{p} \delta_{ij} \Delta y_{i,t-j} + \mu_{it}.$$

In the above equation, μ_{it} represents error term, j represents lag order and β_i denotes deterministic term. In autocorrelation and CSD in residuals, Pesaran (2007) altered the above equation to attain the modified Im et al. (2003) IPS statistics. Mathematically, CIPS can be stated as follows:

$$CIPS = N^{-1} \sum_{i=1}^{N} t_i (N, T).$$

In this equation, $t_i(N, T)$ denotes the t-statistics from the CADF regression.

3.2.3 | Panel cointegration test

The Westerlund panel cointegration approach is used in this study because of the CD among the selected countries (Wasterlund, 2008). As advocated in Westerlund's (2007) and Persyn and Westerlund (2008) studies, this method stresses structural dynamics rather than residual dynamics. Westerlund panel cointegration test depends on four types of test statistics: two depends on the panel and two are based on group statistics.

In the following equation, error correction base cointegration test is estimated:

$$\Delta Y_{it} = \delta_i' d_t + \eta_i \left(Y_{i,t-1} - \beta_i' x_{i,t-1} \right) + \sum_{j=1}^{p_i} \eta_{ij} \Delta y_{i,t-j} + \sum_{j=0}^{p_i} \gamma_{ij} \Delta x_{i,t-j} + \mu_{it}.$$

Group cointegration is estimated by the following equation:

$$G_\tau = \frac{1}{N} \sum_{i=1}^{N} \frac{\eta_i}{SE\left(\hat{\eta}_i\right)},$$

$$G_a = \frac{1}{N} \sum_{i=1}^{N} \frac{T\eta_i}{\eta_i'(1)}.$$

Panel cointegration is estimated by the following equation:

$$P_t = \frac{\hat{\eta}_i}{SE\left(\hat{\eta}_i\right)}$$

$$P_a = T\hat{\eta}_i.$$

In the above equation, η_i represents adjustment term by short-run to long-run equilibrium.

3.2.4 | Pedroni and Kao cointegration test

The Kao (1999) and Kao and Chiang (2000) and Pedroni (1999) cointegration tests are used to determine whether the variables have a long-term relationship. The Kao (1999) method is a stochastic and residual-based test for the null cointegration hypothesis. Pedroni regression equation is:

$$y_{it} = \alpha_i + \delta_i t + \beta_i X_{it} + e_{it},$$

where α_i, δ_i and β_i are open to cross-sectional variations. Pedroni (1999) considers two types of statistics based on the above equation: pool's homogeneous panel cointegration statistics and pool's heterogeneous group mean statistics.

3.2.5 | Long-run estimations methods

To estimate long-run coefficients, this study used FMOLS. The FMOLS method helps remove endogeneity in the regressor and serial correlation in the error term, resulting in asymptotic characteristics in the variables (Dogan and Seker, 2016). Furthermore, by using FMOLS, the non-parametric technique can be used to reduce autocorrelation and endogeneity. Specifically, this study uses weighted FMOLS to eliminate the issue of heterogeneity in a heterogeneous cointegrated panel in the long-run variances (Kao and Chiang, 2000; Mark and Sul, 2003).

3.2.6 | Granger causality

The FMOLS test procedure is used to identify the cointegration among the variables. However, the FMOLS tests do not provide information about the causality direction, which needs to be determined. Therefore, the study applied the cointegration procedure proposed by Dumitrescu and Hurlin (2012) to show the direction of the causality among the variable. This approach is based on W-bar and Z-bar statistics, which are estimated for each cross-section of the variables with a calculated p-value, significant at 1%, 5% and 10%.

4 | RESULTS DISCUSSION

The study used the CADF unit root test recommended by Pesaran (2007) to identify the integration order of the series of the existing study since the study identified the unique order of integration. Therefore, it is important to check the existence of cointegration among the variables. The cointegrations test presumes a long-run relationship between variables, and the variables are integrated in a specific order. The study used Westerlund (2007) testing procedure to check cointegration among the variables. Table 2 presents the results of Westerlund (2007) cointegration test. The results suggest the existence of cointegration among the variables in the long run, as the p-value of G_a is significant at 5%. As a result, the null hypothesis of no cointegration between the variables is rejected.

TABLE 2 Westerlund ECM panel cointegration tests

Statistic	Value	*z*-value	Robust *p*-value
G_t	−2.260	0.326	0.380
G_a	−3.204	2.554	0.020*
P_t	−2.310	1.627	0.540
P_a	−0.762	2.112	0.660

Note: The group statistics are represented by the G_t and G_a values in the table, while the panel statistics are represented by P_t and P_a. The robust *p*-values are derived using 100 bootstrapped replications are used to determine whether the model is cointegrated.

TABLE 3 Pedroni and Kao cointegration test

Panel versus statistic	Statistic	Prob.	Weighted statistic	Prob.
Panel PP-Stat.	−9.9520	0.000	−2.7344	0.0031
P. ADF-Stat	−2.5037	0.0061	−2.5372	0.0056
Individual AR coefs. (between-dimension)				
	Statistic	**Prob**.		
G. rho-Stat	3.2493	0.9994		
G PP-Stat	−5.9894	0.000		
G ADF-Stat	−1.8522	0.0320		
Kao (cointegration test)				
	***t*-stat**	**Prob**		
ADF	−2.2592	0.0119		
Residual variance	0.019831			
HAC variance	0.0070			

Note: The test is performed under no deterministic trend using lag 1, using automatic lag based on Schwarz Information Criterion (SIC) with Newey–West automatic bandwidth selection. PP indicates parametric panel, ADF is Augumented Dickey-Fuller and HAC represents Heteroskedasticity- and Autocorrelation-consistent

Additionally, the study used Pedroni (1999) and Kao (1999) cointegration tests for further robustness of the long-run results after confirming stationarity at the first difference and cointegration in the variables. The Pedroni and Kao cointegration test results are shown in Table 3. The presence of cointegration among the variables in the Pedroni test is supported by five out of six tests. Based on these results, the study concludes the long-run cointegration among the variables. Moreover, the Kao test also concludes that carbon emissions, energy use, FD, GDP growth, tourism arrival, trade and FDI are cointegrated (in the long run). Therefore, the study proposed that these variables are associated with each other in the heterogeneous group of countries in the long run.

Further, after confirming the long-run relationship among the variables, it is necessary to estimate the coefficients of the long-run relationship among the variables. Therefore, the study employed the FMOLS to determine the cointegration coefficient of the elasticity of the long-run relationship. Table 4 describes the results of the long-run coefficients of the variables. The results show that energy consumption is negatively linked with carbon emissions. This further clarifies that a 1% rise in energy consumption reduces environmental pollution by 0.6161%. This implies the importance of clean energy in Thailand, Singapore, Malaysia and Hong Kong for the selected period of the study. Moreover, these countries are currently in an emerging state of development. However, these top tourist destinations also focus on the use of clean and green energy. Moreover, the role of FD is insignificant in the CO_2 emission model. The banking sector needs to enhance by advancing credit to encourage renewable energy products. This will help the economy by shifting the load away from fossil fuel

TABLE 4 Long-run elasticity using fully modified ordinary least squares, dep. var, lnCO_2

Vari.	Cof.	SE	*t*-statistics
ln*E*	−0.6161*	0.1707	−3.6075
ln*FD*	0.0309	0.0551	0.5608
ln*G*	4.5307*	13.0912	3.3995
lnG^2	−4.3817*	1.4130	−3.1009
lnG^3	0.1393*	0.0501	2.7765
ln*TU*	0.6456*	0.0851	7.5797
ln*TRD*	−0.3341*	0.0647	−5.1593
ln*FDI*	0.0362*	0.0107	3.3719
R^2	0.8733		
Adj. R^2	0.8466		
S.E. of reg	0.1419		

*shows significance at 1%.

consumption and will induce the economy towards renewable energy development. Further, the relationship between economic growth is positive at the early stage, negative at the middle stage and then again positive in the later stage. The positive, negative and again positive (G, G^2 and $G^{3)}$ relationship between economic growth and carbon emissions confirms the validity of *N*-shaped EKC. A 1% rise in economic growth significantly causes a 4.5% increase at the early stages, then −4.3% decrease and then again a 0.13% increase in the later stage. The existence of an *N*-shaped EKC suggests that the scale effect is dominant as compared to the technique effect in top tourist countries. The result supports the findings of Bisset (2022) and Rashdan et al. (2021) proposed the existence of *N*-shaped EKC in sub-Saharan Africa and 14 emerging countries. This emphasises implementing clean and green technology that helps in the reduction of carbon emissions. Moreover, Allard et al. (2018) also highlighted the presence of *N*-shaped EKC for lower-income, middle-income and high-income economies. However, our results contradict Gyamfi et al. (2021) that fail to identify the existence of the *N*-shaped EKC curve in the E-7 economies.

The results indicate a negative and significant relationship between trade openness and carbon emissions. A 1% rise in trade openness declines environmental degradation by 0.3341%. This implies that opening up trade in the economy encourages investment in energy-efficient technologies and provides consumers access to high-efficient products, which leads to discouraging non-renewable and non-efficient use of technology. Thus, it reduces environmental degradation by reducing CO_2 emissions. The result supports the findings of Faisal et al. (2020) and Munir and Ameer (2018) while contrasting with Zameer et al. (2020) and Koengkan (2018).

Moreover, Table 4 displays that tourism is exerting a positive impact on environmental pollution. A 1% rise in tourist arrival upsurges environmental degradation up to 0.6456% in the top-four tourist countries in the long run. These economies are strongly encouraged to enhance the quality of their environment through several channels, laws and regulations. The possible reason for the positive relationship between tourism and carbon emission could be that the transportation-related activities, which are closely related to the tourism industry of these economies, use more energy (fossil fuels) and hence promotes CO_2 emission. In addition, it has been noted that hotels and restaurants in every tourist place greatly increase their CO_2 emissions due to the vast garbage they produce. Thus, through this way, tourism degrades environmental quality. The result of the current study is in line with Usman et al. (2021) who concluded an adverse relationship between tourism and environmental quality. Moreover, Li et al. (2022, 2021) discussed that recently the COVID-19 pandemic affected a country's tourism, economic, socio-economic and socio-cultural conditions. On the one side, the drastic reduction in tourism arrival adversely affects economic growth, but on the other hand, it promotes environmen-

TABLE 5 DH causality test

Variables	lnCO2	lnFD	lnE	lnFDI	lnTRD	lnTU	lnG
ln*CO*2	——-	4.16872	3.76825	1.87703	6.31362	2.14668	3.24912
		(1.03407)	(0.78591)	(−0.38604)	(2.36321)	(−0.21895)	(0.46421)
		[0.3011]	[0.4319]	[0.6995]	[0.0181]**	[0.8267]	**[0.6425]**
ln*FD*	0.91224	——-	1.23889	2.91323	3.42737	0.73504	2.52268
	(−0.98390)		(−0.78148)	(0.25607)	(0.57467)	(−1.09371)	(0.01406)
	[0.3252]		[0.4345]	[0.7979]	[0.5655]	[0.2741]	[0.9888]
ln*E*	2.56204	5.16028	——-	1.85549	4.77736	2.00380	2.27867
	(0.03844)	(1.64852)		(−0.39939)	(1.41123)	(−0.30748)	(−0.13715)
-	[0.9693]	[0.0992]***		[0.6896]	[0.1582]	[0.7585]	[0.8909]
ln*FDI*	2.13308	1.91511	4.61238	——-	2.18468	5.41828	7.88689
	(−0.22737)	(−0.36245)	(1.30899)		(−0.19540)	(1.80839)	(3.33813)
	[0.8201]	[0.7170]	[0.1905]		[0.8451]	[0.0705]***	[0.0008]*
ln*TRD*	3.10311	5.68832	3.59263	2.26074	——-	1.01058	4.16888
	(0.37373)	(1.97573)	(0.67708)	(−0.14826)		(−0.92296)	(1.03417)
	[0.7086]	[0.0482]***	[0.4984]	[0.8821]		[0.3560]	[0.3011]
lnTU	3.63257	6.97878	2.33117	3.96184	4.66900	——-	0.89452
	(0.70183)	(2.77540)	(−0.10462)	(0.90587)	(1.34408)		(−0.99488)
	[0.4828]	[0.0055]*	[0.9167]	[0.3650]	[0.1789]		[0.3198]
ln*G*	2.67007	10.0738	2.43872	4.31324	6.67354	3.43040	——-
	(0.10539)	(4.69333)	(−0.03797)	(1.12362)	(2.58625)	(0.57655)	
	[0.9161]	[0.000003]*	[0.9697]	[0.2612]	[0.0097]*	[0.5642]	

Note: The test considered the null hypothesis of no causality; the top value shows W-stats; () shows *z*-value; and values in [] represent *p*-value *shows 1% significance level; ** shows 5% significance level; *** shows 10% significance level.

tal quality. Also, the findings of Liu et al. (2022) demonstrated that social value creation mediates the connections between social entrepreneurship and environmental sustainability as well as cultural tourism and environmental sustainability. Therefore, this indicates that the social value creation of a business promotes environmental sustainability through tourism. The results demonstrate that FDI has a positive and significant impact on CO_2 emissions. A 1% rise in the inward movement of FDI raises CO_2 emissions by 0.0362%. Moreover, the R^2 in the results describe that 87% of the change in CO_2 emissions is explained by energy consumption, FD, trade, economic growth, tourism and FDI.

Further, the study utilised Dumitrescu and Hurlin's (2012) panel causality technique to determine the direction of causality between the variables. This approach consists of W-bar and Z-bar statistics and *p*-value. The results of the D-H causality are shown in Table 5.

The D-H causality results in Table 5 reveal a unidirectional causality from energy usage to domestic credit to the private sector (FD). This indicates that higher energy consumption induces economic growth (Gómez and Rodríguez, 2019), while higher economic growth enhances savings and development. Thus, the banks provide more credit to the private sector. The unidirectional causality from trade, tourism and economic growth to domestic credit to the private sector is also identified in the results. This represents that more tourism arrival and increases in trade activities in the country upsurge the economic growth, which positively affects the financial system development. Moreover, the unidirectional relationship that moves from GDP to FD confirms the supply-leading hypothesis; thus, the economy is responded well by economic growth and facilitated by the FD. The higher economic growth demands more financial products in the market, emphasising the role of FD in the economy.

According to Schumpeter (1911), financial intermediaries play a vital role in mobilising savings and investment, analysing projects, risk mitigation and facilitating transactions necessary for economic growth. Our results support the findings of Al-Mulali et al. (2012). Further, these findings of the study also support Khan et al. (2019) results. Moreover, the study identifies a unidirectional causality from GDP to trade and from FDI to tourism arrival and GDP. This shows that increased inward FDI provides investors and entrepreneurs with better opportunities to operate their businesses, especially in the tourism sector, leading to increased economic growth. The results support the finding of Kreishan (2010).

5 | CONCLUSION

Currently, environmental sustainability is a series issue around the world for which the economies are trying to reduce environmental degradation. Tourism development is a significant determinant that attracts foreign FDI and promotes financial and economic development. The increasing economic growth due to tourism expansion raises the demand for energy consumption and other natural resources that affect environmental quality. This current study examines the existence of *N*-shaped EKC in the top-four Asian tourist countries while employing various methodological techniques. The study used Pesaran's (2004) and Breusch and Pagan's (1980) CD test and identified the cross-sectional dependency. Further, to check the stationarity in the data, Pesaran's (2007) CADF test is utilised, confirming cointegration order *I*(*1*). The study further employed the Westerlund (2007) test to check the cointegration while considering the cross-sectional dependency. The Westerlund (2007) test confirmed the possible cointegration among variables in the long run. The study utilised Pedroni and Kao cointegration tests for further robustness of the findings. The Pedroni cointegration test statistics indicated that four out of five findings rejected the null hypothesis of no cointegration. The results, therefore, proposed the cointegration among CO_2 emissions and independent variables. The FMOLS test was used to assess the long-run coefficients of variables that account for endogeneity and serial correlation in the panel data. FMOLS results suggest that tourist arrivals and FDI exert a positive and significant effect on CO_2 emissions. While energy usage and trade influence environmental pollution negatively. At the same time, the study results validated the *N*-shaped EKC hypothesis, which reveals that industrialisation leads to increased economic growth and causes environmental degradation. After reaching a threshold level, tourism and FDI is likely to enhance the investment in environment-friendly technologies, which reduce carbon emissions. Thus, consequently confirming the existence of the EKC in the top-four tourist countries. The higher productivity of industries leads to increased economic growth and therefore upsurges in environmental pollution.

Moreover, it can be argued that top tourism economies can experience maximum economic growth due to tourism arrival and FDI, which are crucial in environmental quality. Moreover, literature explored that these variables are linked with each other (Liu et al., 2022b; Rahaman et al., 2022; Dogan et al., 2017). Any unfavourable shock in the economy affects all these variables, such as COVID-19. The COVID-19 pandemic had several negative effects, including social and behavioural changes, economic shock and difficulties for organisations to carry on with business as usual (Azizi et al., 2021). Thus, these variables could affect the quality of the environment.

The study finally used the granger causality test, as recommended by Dumitrescu and Hurlin (2012), to show the direction of the causality relationship among the variables. The result shows unidirectional causality from trade, tourism and economic growth to FD. Tourism-advanced countries get handsome inflow from the tourism sector that could enhance financial activities, trade, employment and financial and economic development. The higher tourism sector attracts investment that leverages tourism, thus promoting economic growth. Moreover, FDI is causing tourism and economic growth. A huge influx of FDI leverages the tourism sector and thus ultimately contributes to economic growth.

6 | POLICY IMPLICATIONS

Moreover, based on empirical results, the study recommends various policy implications to top tourism countries in minimising CO_2 emissions. To reduce carbon emissions, it is highly recommended that government must impose a carbon tax on large energy consumers and encourage renewable and small energy consumers to decrease environmental degradation. Government should prefer green projects and should offer tax subsidies and tax relief to promote green finance. The results elaborated statistical evidence that economic growth and energy consumption are the main determinants causing CO_2 emissions. Owing to increase environmental quality, the government may take a series of actions to control CO_2 emissions. Policymakers may review their existing policies for strict ecological control and should develop a new set of guidelines that concentrate on renewable energy sources to curtail carbon emissions. The government must promote the use of electric cars to lessen environmental pollution.

Further, owing to enhancing the quality of the environment, the top-four tourist countries should control and regulate the tourism industry. In the top-four tourist countries, tourism contributes significantly to environmental degradation. In order to lessen environmental degradation due to the tourism industry, these countries should adopt green tourism practices, comparable with the sustainable tourism goals of the United Nations. Further, clean mobility and zones for the tourism industry are also helpful in lowering lower CO_2 emissions. Another way is to successfully recycle the trash produced by visitors in order to prevent environmental degradation as much as feasible. Further, tourist countries can reduce their CO_2 emissions through increasing trade openness and the importation of eco-friendly technologies. In this regard, these countries ought to support international trade laws and initiatives that supply technology that encourages green innovation and clean energy usage. Additionally, the government must encourage FDI to develop renewable energy projects in order to boost GDP while also reducing pollution.

According to Pata et al. (2022), Singapore is one of the considered top-four tourist countries. Singapore has been successful in achieving its objectives of economic growth, sustainable development and providing good living standards to its citizens in recent years. Over the last 24 years, the average growth rate of Singapore was 5.37% (World Bank, 2022). However, Singapore has successfully reduced its carbon emissions along with this rapid economic development (Zambrano-Monserrate et al., 2018), and it is the only one of the ASEAN group of countries to minimise its carbon emissions. Moreover, in order to enhance environmental quality, Singapore established its Environmental Pollution Act in 1999, and it is also pledged to Paris Agreement (2015) to reduce its carbon emissions upto 36% by 2030 (UNFCC, 2018). Keeping the example of Singapore, other top tourist countries should follow the acts and policies of Singapore in order to contribute to the protection of environmental degradation. Moreover, the study's outcomes would also be helpful to decision-makers who oversee issues related to environmental quality because they would help them in implementing policies that would encourage a healthy environment and shield future generations from the severe impacts of environmental degradation as a result of tourism development through the FDI and economic growth channel. For nations grappling with environmental pollution challenges in today's globalised world, integration of environmental preservation policies with the macroeconomic objectives appears to be a policy instrument to emulate.

7 | LIMITATIONS OF THE STUDY

While conducting this study, the availability of the data for certain parameters of the study was till 2014. Therefore, this study preferred to use the data only till 2014, which is one of the limitations of this study. Future studies in this regard can be conducted using the ecological footprint, a comprehensive proxy for measuring environmental pollution. Moreover, the asymmetric technique needs to be adopted to get a better insight into time-series analysis.

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflict of interest.

DATA AVAILABILITY STATEMENT

Not Provided.

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ORCID

Faisal Faisal https://orcid.org/0000-0003-1818-3418
Adnan Ali https://orcid.org/0000-0003-4051-3153

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