



# Tourism growth and environmental sustainability: trade-off or convergence?

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## Abstract

Besides its socioeconomic benefits, tourism has been documented as one of the leading sectors with deleterious effects on the environment. This study investigates the relationship between tourism dynamics and environmental sustainability using biennial data for 148 countries over the period from 2006 to 2016. The first step develops a tourism growth index that encompasses various dimensions of tourism development and various panel cointegration techniques are then employed to characterize the dynamic association between environment sustainability and tourism growth. Empirical results reveal that tourism growth and environmental sustainability are indeed convergent not only for the full sample countries but also across geographical regions and socioeconomic clusters. In addition, a negative impact of tourism growth on the environmental welfare is evidenced in the long term; suggesting a trade-off between tourism activities and environment performance for the full sample over the past decade. At the regional level, similar finding is reported for Asia and Europe against a positive environmental impact for America and an inconclusive output for Africa. The observed difference might be attributed to the heterogeneity in the unsustainability level of regional tourism development with limited exposure for Africa and America. Interestingly, the convergence of tourism growth and environment well-being tends to exhibit varied speeds of adjustment across sample panels. The observed differences could be attributed to the country-level switching propensity from environment-harmful tourism practices as well as their socioeconomic characteristics. Consequently, policies geared towards minimizing the adverse environmental effects should be integrated with countries tourism management policies to enable the transition to sustainable tourism sector development. Thus, targeting nature tourism becomes a critical approach to tourism development rather than setting traditional goals such as number of visitors, income stream and employment.

**Keywords** Environment sustainability · Tourism · Panel cointegration

**JEL Classification** C23 · L83 · Q56

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## 1 Introduction

In the midst of changing climate with its widespread environmental consequences, there has been a growing concern that human activities exacerbate the deterioration of environment including land degradation (Li et al., 2016), ecosystem damaging (Mahmoud & Gan, 2018), pollution (Rajé et al., 2018), overexploitation of natural resources (Dong et al., 2014), biodiversity loss (Mona et al., 2019) and habitat destruction (Tian et al., 2020). It has, therefore, become critical for academics, policymakers and environmental development agencies to understand the mechanisms through which human actions affect the environment in order to safeguard the natural capital, indispensable for the survival and development policies of human societies.

Though all human activities bear some consequences on environment,<sup>1</sup> natural resources and environmental assets remain crucial for the continuous flow of goods and services and this is particularly important for the tourism sector, one the world's largest industries. According to Pigram (1980), environment is not only a constraint for tourism but also an opportunity as well as a resource. As a result, tourism activities can contribute to environmental sustainability but can equally lead to environmental degradation; the net effect of which depends on the type of tourism and contextual characteristics such as level of technology, environment awareness and societal life style.

To unpack the complex relationship between tourism and environment, Anup and Parajuli (2014) distinguish between nature-based tourism and large-scale tourism. Nature-based tourism is driven by the protection and conservation of natural resources, which is conducive to sustainable environment. Conversely, large-scale tourism focuses on touristic physical infrastructures for economic gains, resulting in both positive and negative environmental impacts. Illustratively, Nicholas and Thapa (2010) argue that visitors' behaviour and attitude towards environment are likely to stress the ecological sustainability of the touristic site. In addition, 50% of the ecosystem productivity loss are estimated to result from the direct effect of tourists and/or land clearing due to physical infrastructure required for the development of tourism industry (Blersch & Kangas, 2013). However, the economic proceeds from large-scale tourism can support livelihood diversification (Guha & Ghosh, 2007), raise living standard and mitigate poverty through employment and entrepreneurship (Ramamany & Swamy, 2012) with long-term environment enhancing effects. Thus, the continuous development of the tourism industry requires a good balance between economic benefits and environment cost, which can be achieved through the implementation of ecotourism (Adhikari & Fischer, 2008). It emerges that tourism and environment are rather interdependent, with ecotourism contributing to environmental sustainability and environment being an input to tourism industry.

Against this background, the present investigation hypothesizes and tests the joint integration between environmental sustainability and tourism growth by means of cointegration analysis applied to a panel of 148 worldwide countries over the sample period from 2006 to 2016. Numerous studies have endeavoured to analyse the pollution impact of tourism growth, many of which are linked to infrastructure construction such as roads, airports and tourism facilities. Considering that tourism development brings about conservation

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<sup>1</sup> An extensive literature exists on the determinants of environment quality, most of which advocating the detrimental effect of energy consumption, urbanization, industrialization, globalization, economic growth and financial development (Brahmasrene and Lee, 2017; Ehigiamusoe & Lean, 2019; Akadiri et al., 2019; Ehigiamusoe et al., 2020a among others).

and protection of natural resources (Sunlu, 2003), these studies mainly focus on partial impact assessment with little or no attention to the net environmental effect of tourism, which, however, requires a holistic measure of environment quality. A recent exception by Pulido-Fernández et al. (2019) studies the relationship between tourism growth and environment performance using a multidimensional definition of environment quality comprising of institutional, regulatory, energy and climate factors. They achieve this based on structural equation modelling, which does not allow differentiating between short-term and long-term effects.

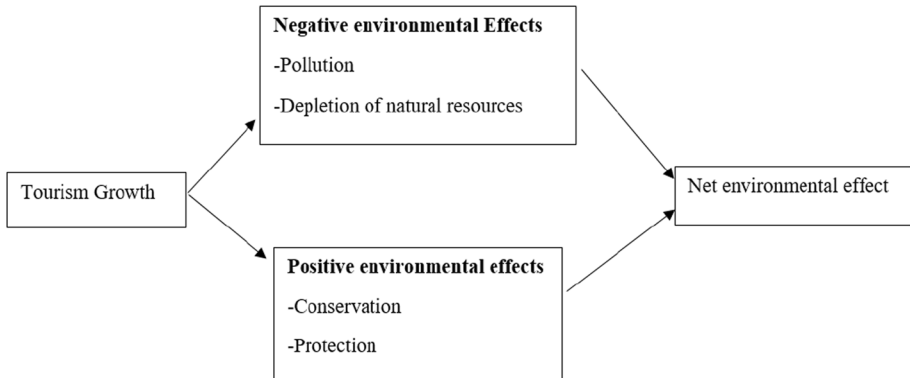
Following Pulido-Fernández et al. (2019), this study assesses the environmental effect of tourism using the environmental sustainability index built from various environmental quality measures including natural resources, energy and climate. Differently from these authors, the panel approach to cointegration is adopted, which is useful in characterising the long-term relationship between non-stationary or semi-stationary variables by mean of an error correction representation; hence describing the short-term dynamics towards a possible long-run equilibrium relationship understood in this paper as convergence. This analytical framework further helps mitigate the issue of unobserved characteristics of tourism destinations and is general robust to the presence of endogeneity (Pedroni, 2019). Moreover, it allows for comparative analysis across different regions and/or clusters, which is quite informative for targeted policy strategies rather than one-size-fit-all policy interventions.

The rest of the paper is organised as follows. The next section reviews the relevant literature followed by the empirical methodology. Preliminary analysis and empirical results are then discussed in Sects. 4 and 5, respectively. And the last section provides concluding remarks and policy implications.

## 2 Literature review

Pigram (1980) provides a complete theoretical framework for understanding the interdependence between environment and tourism. On the one hand, this framework considers environment as both resource and constraint to tourism growth. In this scenario, environment is portrayed as the determinant of tourism with possible negative and positive outcomes. For nature-based tourism where the core activities are based on natural attractions (such as camping, fishing, hiking, hunting and visiting parks), environmental capital is expected to have a positive effect on tourism development. Conversely, environment protection might restraint tourism expansion, mainly for large-scale tourism operating in a highly regulated contexts where tourism firms are forced to limit their activities in compliance to environmental regulations and policies.

On the other hand, Pigram (1980) ascribes to tourism growth both environmental degradation and enhancement; hence emphasizing the role of tourism in determining environmental quality (see Fig. 1). Accordingly, the development of tourism is thought to have environmental enhancement mechanism through the improvement of recreational resources. These include opening up forests and water-based resources for recreational use (such as streams, lakes and coastline), increasing cultural consciousness, which may result in restoration of historic sites and antiquities (Haulot, 1978) and building environmental harmony from “cultural multiplier” that may result in social interaction between locals and visitors. Furthermore, tourism expansion and modernization bring about economic support and useful adjustments to climate in the form of recreational structures, clothing,



**Fig. 1** Theoretical framework for Tourism growth and environment performance

technology and equipment to improve conservation through enhanced habitat management, wildlife and pest control, ecotourism skill training and practices (Anup & Parajuli, 2014; Pigram, 1977). Despite the potential environmental enhancement, tourism expansion leads to environmental destruction. Since Gunn (1973), pollution is known as an obvious manifestation of the harmful effect of tourism besides the depletion of natural resources and waste management problems. Moreover, tourism puts increased pressure on land use which can lead to soil erosion, natural habitat loss and ultimately ecosystem destruction. These deleterious effects can be exacerbated by technological innovations and inappropriate construction styles of tourism facilities (Pigram 1980).

Empirically, the environment–tourism nexus remains controversial, most studies analysing either the environmental risk factors associated with tourism activities or the enforcement strategies to sustainable tourism. In terms of risk factors, some studies have provided evidence in support of the detrimental effect of tourism on environment, most of which focusing on pollution (Koçak et al., 2019; Ren et al., 2019; Shaheen et al., 2019 and Russo et al., 2020 among others). While these studies are consistent with the use of CO<sub>2</sub> emission as proxy of environmental quality and the need to account for control variables in depicting the true causal effect of tourism, Russo et al. (2020) estimated tourism emissions at about 67.6% in the aviation sector and Koçak et al. (2019) documented a comovement between tourism development and CO<sub>2</sub> emissions. However, Brahmasrene and Lee (2017) found a negative effect of tourism on CO<sub>2</sub> emissions in Southeast Asia after controlling for urbanization, industrialization, globalization and economic growth. Ehigiamusoe (2020b) reported mixed effects of tourism expansion on CO<sub>2</sub> emissions across a panel of African countries; concluding that tourism activities reduce environmental degradation at their early stage of development, but this effect turns to be positive as tourism activities develop. More interestingly, Anup and Parajuli (2014) found that tourism development improves the livelihood in Manaslu conservation area of Nepal, indicating that nature-based tourism is rather environmental enhancing. Lastly, Zhang and Liu (2019) found no causal linkages between tourism and CO<sub>2</sub> emissions and concluded that non-renewable energy consumption is responsible of harmful emissions in Asian countries. However, all these studies generally recommend ecotourism as key solution to ensure the continuous development of tourism industry; hence, the need to enforce sustainable practices in this sector.

From the enforcement strategy perspective, Beladi et al. (2009) showed that pollution tax reduces the pollution emissions from tourism activities and has a positive causal

term-of trade effect on tourism exports. In the same vein, Holden (2009) demonstrated the role of market ethics in restoring the balance tourism–environment. Besides the regulatory enforcement, Amelung et al. (2016) documented the systemic approach to address the deleterious effect of tourism on the environment. This approach integrates environmental practices and heterogeneous stakeholders' behaviours and needs to derive agent-inclusive strategies with potential to be effective in environmental sustainability research for tourism.

Though ecotourism has become imperative for the sustainability of tourism industry, Pulido-Fernández et al. (2019) deplored the absence of compliance to sustainable practices in the tourism industry. This unwillingness to comply with sustainability principles is motivated by a number of reasons including the high switching costs compared to limited benefits (Black & Crabtree, 2007); the restricted practical sustainability packages available for stakeholders (Welford et al., 1999) and the emphasis on short-term switching consequences in public dialogs (Robert et al., 2002).

Considering that CO<sub>2</sub> emission represents a single dimension of environmental quality, without a holistic measure of environment performance, the existing literature has provided a partial characterisation of tourism–environment nexus. Differently from previous studies, Pulido-Fernández et al. (2019) made use of multiple proxies of environmental quality comprising of regulatory, institutional, climate and energy factors to establish a supportive evidence of a bidirectional relationship between environment performance and tourism growth based on a structural equation framework. Contrary to Pulido-Fernández et al. (2019), this study hypothesizes a comovement between tourism growth and environment quality in the long run. The existence of comovement between time series variables is alluded to the cointegration relationship; hence motivating the use of cointegration method that is suitable to study behavioural linkages. Unlike structural equation modelling, the cointegration captures an important feature of time series analysis, which helps isolate the long-term effect from the short-run impact. This leads to the hypothesis that tourism development may have different environmental outcome in short term and in longer term. These research hypotheses are tested at different levels of analysis, namely global, regional and country levels, hence allowing for cross-regional as well as cross-country comparisons. Moreover, the study uses a composite environmental sustainability index, which encompasses the three main dimensions of environment quality: natural resources, climate and energy.

### 3 Empirical methodology

Consistently with the main goal of analysing the convergence between environmental sustainability and tourism growth, the empirical investigation follows a four-step procedure to achieve the related specific objectives. The first step ascertains the stationarity property of the studied variables as pre-testing conditions since cointegration requires some if not all variables to be non-stationary. The second step evaluates the existence of long-term stationarity between variables under study also known as long-term relationship and this is achieved through cointegration testing. The third step estimates the hypothesized cointegrated relationship with the aim of characterizing its dynamics in terms of identifying the speed of adjustment towards the long-term equilibrium, the short- and long-term effects. This procedure ends with the robustness analysis, which ensures the consistency of the estimates for a valid inference.

### 3.1 The pre-testing conditions: Im-Pesaran-Shin (IPS) panel unit root test

In time series analysis, stationarity plays a key role in determining the appropriate empirical strategy. Accordingly, the study of long-term relationship among variables requires at least some variables (if not all) to be non-stationary.<sup>2</sup> We chose the IPS variant of the panel unit root based on its flexibility in accommodating the structure of the selected dataset.

Unlike the first-generation panel unit root tests that require balanced panels and assume common autoregressive parameters for all panels (that is homogeneity), IPS test is one of the panel unit root tests that assumes heterogeneity across panels. This test considers all panel to be heterogeneous and tests the null hypothesis that all panels have a unit root against the alternative that some panels are stationary. It has the advantage to accommodate panels with fixed time series (T) and provides critical values for both fixed and large cross sections (N).

Specifically, IPS test relies on panel specific set of Dickey–Fuller regressions of the form:

$$\Delta X_{it} = \phi_i X_{i,t-1} + Y'_{it} \gamma_i + \sum_{j=1}^p \Delta X_{i,t-j} + \varepsilon_{it} \quad (1)$$

where  $i = 1, \dots, N$  indexes countries;  $t = 1, \dots, T_i$  indexes time;  $X_{it}$  is the time series being tested (that is tourism growth index or environmental sustainability index in the present case);  $Y_{it}$  is the panel specific means and/or time trend, or nothing, depending of the test options and the  $\varepsilon_{it}$  is the error term, independent and normally distributed for all  $i$  and  $t$  with heterogeneous variances  $\sigma_i^2$  across countries. Similar to the errors variances,  $\phi$  is indexed by “ $i$ ”; allowing the formulation of the null hypothesis that  $\phi_i = 0$  for all  $i$  (that is all panels contain a unit root).

Equation (1) is fitted for each country and IPS test is then computed as the average of individual t-statistics across countries. Formally, if  $t_{iT_i}(p_i)$  is the t-statistics from individual regression,

$$\bar{t}_{iT_i} = \frac{1}{N} \sum_{i=1}^N t_i(p_i) \quad (2)$$

The standardised version of t-bar has been shown not only to have better performance when N and T are small but also to converge to the standard normal distribution as N and  $T \rightarrow \infty$ .

### 3.2 Panel cointegration tests

As an exploratory framework for long-term relationships, cointegration remains an important revolution in time series analysis. While ordinary least squared (OLS) may lead “spurious” results if applied to non-stationary times series, it is now standard to find possible stationary linear combinations among non-stationary variables. This is known as cointegration also referred to as long-term equilibrium relationship. Its existence implies that individual variables with divergent behaviours in the short run eventually converge to common long-run paths.

<sup>2</sup> A stationary process denoted I(0) is characterized by time-invariant mean and variance. Otherwise, it is non-stationary and can be I(1) or I(2) depending on whether the stationarity is achieved after the first or the second difference, respectively.

Illustratively, this study hypothesizes and tests the presence of a stable relationship between tourism development and environmental performance in the long-run despite their tendencies to wander arbitrary over time. To this end, cointegration tests applied to a panel setup are considered given the nature of the dataset. Particularly, use is made of Kao (1999), Pedroni (1999 2004) and Westerlund (2005) panel cointegration tests. These tests are based on panel data model of the form:

$$EVWB_{it} = \beta_i TG_{it} + Y'_{it} \gamma_i + u_{it} \tag{3}$$

where  $EVWB_{it}$  is the environmental performance index and  $TG_{it}$  denotes the tourism growth variable in country  $i$  at time  $t$ ;  $u_{it}$  is the error term independent and normally distribute for all  $i$  and  $t$ ; and  $Y_{it}$  remaining as previously defined.  $EVWB_{it}$  and  $TG_{it}$  are required to be  $I(1)$  series.  $Y_{it} = 1$  by default so the term  $Y'_{it} \gamma_i$  represents country-specific means (fixed effects). Therefore, the cointegrating relationship is specified as:

$$EVWB_{it} = \gamma_i + \beta_i TG_{it} + u_{it} \tag{4}$$

All these tests have the null hypothesis of no cointegration between  $EVWB_{it}$  and  $TG_{it}$ . However, the alternative hypothesis of Kao test and Pedroni tests is that these variables are cointegrated in all countries, whereas Westerlund test has two versions where the alternative hypothesis is that variables are cointegrated in some countries (version 1), or cointegration is across all the countries (version 2). These tests essentially test whether  $u_{it}$  is non-stationary; the rejection of the null of no cointegration corresponding to  $u_{it}$  being stationary.

### 3.3 Method of estimation

In the empirical literature, cointegration is a popular approach to analyse dynamic relationships. In the panel data framework, this approach has specific advantages. Besides its flexibility in accommodating both short-term and long-term dynamics, it accommodates a wide range of estimation techniques while improving the efficiency of estimates due to low-collinearity and high degree of freedom benefits by combining both cross section and time characteristics. To estimate the cointegration relationship, used is made of the mean group (MG) proposed by Pesaran and Smith (1995), the pooled mean group (PMG) proposed by Pesaran et al. (1999) and the dynamic fixed effect (DFE). Unlike the DFE estimator, the MG technique assumes country-specific intercepts, slope coefficients and error variances, while the PMG method combines both pooling and averaging by compelling long-run estimates to be equal across countries and all other estimates remaining country specific.

Assuming the long-run environmental sustainability specification (Eq. 4), the one lag dynamic panel specification of (4) is:

$$EVWB_{it} = \gamma_i + \delta_{10i} TG_{it} + \delta_{11i} TG_{i,t-1} + \lambda_i EVWB_{i,t-1} + u_{it} \tag{5}$$

The error correction representation of (5) is given by:

$$\Delta EVWB_{it} = \phi_i (EVWB_{i,t-1} - \theta_{0i} - \theta_{1i} TG_{it}) + \delta_{11i} \Delta TG_{i,t-1} + u_{it} \tag{6}$$

where  $\phi_i = -(1 - \lambda_i)$ ;  $\theta_{0i} = \frac{\gamma_i}{1 - \lambda_i}$  and  $\theta_{1i} = \frac{\delta_{10i} + \delta_{11i}}{1 - \lambda_i}$ .

The maximum likelihood method is used to estimate the parameters. The error correction term,  $\phi_i$ , referred to as speed of adjustment parameter and the long-run coefficient,  $\theta_{1i}$ , are the main estimates of interest. The inclusion of  $\theta_{0i}$  allows a nonzero mean of the

cointegrating relationship. If  $EVWB_{it}$  and  $TG_{it}$  depict a return to long-term equilibrium,  $\phi_i$  is thought to be negative and statistically significant.

Equation (5) is, in fact, similar to a fixed effect model with lag-dependent variable. This representation offers the possibility to use the dynamic fixed effects (DFE) as alternative estimator.

### 3.4 Robustness analysis

The main drawback of PMG, MG and DFE estimators is that they are generally consistent when both time dimension (T) and cross-sectional dimension (N) are relatively large with downward bias issues in short panels (Pesaran and Smith, 1999). However, Breitung and Pesaran (2008) indicate that the analysis is still possible for small T (less than 10) with large N (greater than 100) but under restrictive assumptions such as dynamic homogeneity and/or local cross section dependence as it is the case in the present study. To confirm the relevance of these assumptions for robustness purpose, the study employs the common correlated effect (CCE) estimator, which is consistent in the presence of cross-sectional dependence while ensuring small sample time series correction bias<sup>3</sup> (Chudik and Pesaran, 2015).

The CCE estimator assumes a multifactor error structure to deal with dependencies across units in heterogeneous panels. In an estimated specification, this is achieved by expanding the right hand side equation to include the cross-sectional means; which inclusion has been shown to result in estimator consistency gain (Chudik and Pesaran, 2015). Accordingly, CCE estimator is based on the modified version of Eq. (5) as specified below:

$$EVWB_{it} = \gamma_i + \delta_{10i}TG_{it} + \delta_{11i}TG_{i,t-1} + \lambda_i EVWB_{i,t-1} + \sum_{l=0}^p \theta_{il} \bar{Z}_{t-l} + u_{it} \quad (7)$$

where  $\bar{Z} = (\overline{EVWB_{it}}, \overline{TG_{it}})$  is the vector of cross section means (contemporaneous means).

However, the estimation of Eq. (7) requires a greater sample time series. This is made possible by converting time series frequency from biennial into annual frequency; moving our panel data structure from (N = 148, T = 6) to (N = 148, T = 11).

## 4 Data and preliminary analysis

The empirical analysis combines information from multiple sources. The environmental well-being index compiled by the Sustainable Society Foundation<sup>4</sup> (SSF) at the biennial frequency was used to quantify the environmental sustainability and the data are available for the years 2006, 2008, 2010, 2012, 2014 and 2016. These dates further apply to tourism growth data although available yearly. Five indicators are commonly used in tourism studies to measure tourism growth: contribution to GDP, government expenditure to travel and tourism, contribution to employment, capital investment in travel and tourism sectors, and visitors' exports. In line with the main objective of estimating the net environmental effect of tourism expansion, a composite index is constructed from these tourism indicators since

<sup>3</sup> This is implemented in Stata using the command `xtcce2` proposed by Ditzen (2018).

<sup>4</sup> <http://www.ssfindex.com/data-all-countries/>.



each of them may have different impact on environment. In addition, it also reduces the data dimension, while ensuring the tractability of the model given the short time series.

The role of the World Travel and Tourism Council (WTTC) was indispensable in identifying and collecting tourism data from the Tourism Impact Data and Forecast database. Selected tourism impact data from this database were then used to build the tourism growth index (TG) based on the principal component analysis (PCA). PCA is a statistic procedure that helps convert a large number of possible correlated variables into a smaller number of uncorrelated variables named components and this happens without loss of information. Illustratively, this study has identified five indicators of tourism growth (listed in Table 1). Including all these variables in a model may lead to overfitting with possible multicollinearity problem as some of these variables are correlated. With the use of PCA, the set of tourism growth indicators have been transformed into a single index; therefore mitigating both overfitting and multicollinearity issues. Table 2 provides detailed definitions, source and transformation/construction of all the variables involved in the study (where technical details on PCA are provided in “Appendix 3”).

Table 2 gives the summary statistics including the cross-sectional dependence test. Tourism growth index oscillates between -2.665 and 2.914, while the environmental well-being index has a minimum of 1 and a maximum of 69. On average, tourism growth index stands at -0.043 with a standard deviation of 1.291, while the environmental sustainability index has a mean of 36.257 for a standard deviation of 17.875. In addition, the cross-sectional dependence test has a small probability for both variables, therefore refuting the null hypothesis of cross-sectional independence. The sample countries under study appear not only to be heterogeneous but also mutually dependent consistently with the restrictive assumptions requirement for panel cointegration when T is small and N is relatively large.

While environmental impact is likely to materialize within a long-term horizon, the restricted sample period of 2006–2016 was conditioned upon the availability of sustainability index data. The same criteria apply to the selection of 148 countries. A preliminary analysis indicates that, in general, countries with high tourism growth have medium to low environmental performance. With tourism development having more economic bearing, this apparent trade-off between tourism growth and environmental well-being is consistent with the exhibit in “Appendix 2”, showing that high environmental welfare regions have relatively low economic performance. However, a few countries can be found which rank high in both environmental sustainability and tourism growth namely Cameroon, Central African Republic, Guinea, Lesotho, Malawi, Mali, Nepal, Senegal and Sierra Leone (see Tables 3 and 4 and “Appendix 1”). Most of these countries are from Africa where the level of environmental degradation is relatively restricted compared to the rest of the world (see “Appendix 2”). One may then conjecture that the meagre development performance in this part of the world might have helped conserve natural reserves and biodiversity that fuel modern tourism.

## 5 Results and discussion

In line with the stationarity prerequisite for cointegration analysis, Table 5 reports on the IPS panel unit root test performed to the level and first different forms of each of the variables. Results indicate that both variables for all countries and regions are integrated of order one, that is I(1) with the exception of the environment index for America which is I(2).

**Table 1** Variables definition. *Source* Author, Pulido-Fernandez et al. (2019), <http://www.ssfindex.com/data-all-countries/>

Variables	Description	Source
Tourism Growth (TG)	Author's built index from five tourism growth indicators, namely contribution to GDP, contribution to employment, visitors exports, capital investment and government spending on travel and tourism	Author
Total contribution to GDP	GDP generated by direct Travel and Tourism industries plus indirect and induced contributions, including the contribution of capital investment spending (percentage of GDP)	WTTC
Total contribution to employment	The number of jobs generated directly in the Travel & Tourism industry plus indirect and induced contributions (percentage share of total employment)	WTTC
Visitors Exports	Spending within the country by international tourists for both business and leisure trips, including transportation spending (percentage of exports)	WTTC
Capital Investment	Capital investment spending by all sectors directly involved in the Travel & Tourism industry. This also constitutes investment spending by other industries on specific tourism assets such as new visitor accommodation, passenger transportation equipment, as well as restaurants and leisure facilities for specific tourism use (percentage of total investment)	WTTC
Government expenditure	Government spending on travel and tourism (percentage share of total government individual expenditures)	WTTC
Environmental sustainability (EVWB)	Environmental well-being score comprising of two main indicator categories: (i) natural resource and (ii) climate and energy	SSF
Natural resource	Environmental indicator capturing biodiversity, renewable water resources and consumption	SSF
Climate and Energy	Environmental indicator capturing energy use, energy savings, greenhouse gases and renewable energy	SSF

Similar to the unit root test, the panel cointegration tests are implemented both for the panel as a whole (all countries) and for individual region. Table 6 reports the results of the three bloc tests where it appears that the null hypothesis of no cointegration is, in general, rejected for all countries and across different regions. The rejection of the null hypothesis infers the convergence towards the long-term equilibrium. Essential to note is the limited instances in which some variants of the tests fail to reject the null hypothesis, particularly in regional scenarios; possibly indicating the level of heterogeneity in cross-country convergence within regions. However, this is further assessed in the estimation of the cointegration equation; which not only provides long- and short-run coefficients but most importantly the speed of adjustment parameter whose sign and significance help confirm the existence of the cointegration relationship.

Table 7 displays the PMG, MG and DFE results characterizing the long-term relationship between environment performance and tourism growth for the full sample countries. The Hausman test, which compares PMG to MG, fails to reject the null hypothesis that PMG estimates are consistent. In addition, the PMG estimates corroborate the DFE output; hence validating the PMG results for inference purpose. Panel A of Table 7 displays a negative and significant long-term coefficient of tourism growth across data frequencies; indicating a trade-off between tourism development and the environment performance for the full sample. This result remains robust after controlling for cross-sectional dependence

**Table 2** Summary statistics

	Mean	Std Dev	Min	Max	CD test
TG	-0.043	1.292	-2.665	2.915	2.99 (0.003)
EVWB	36.257	17.875	1	69	15.31 (0.000)

Pesaran (2004) CD test has the null of cross-sectional independence against the alternative of cross-sectional dependence

as evidenced in the first column of Table 10, panel A and implies that the development of the tourism sector may come at the cost of environmental degradation and vice versa; thus suggesting that tourism growth has not been sustainable over the sample period. This finding is consistent with the environmental degradation hypothesis elucidated by Pigram (1980) and empirically supported by some authors including Koçak et al. (2019), Ren et al. (2019), Shaheen et al. (2019) and Russo et al. (2020). Furthermore, the error correction term (ECT) is negative and significant; confirming the cointegration relationship and henceforth the convergence between environmental welfare and tourism growth. This finding implies that tourism development and environmental sustainability move together from their disequilibrium positions to a common steady state. Standing at -0.595 in biennial analysis, the ECT infers that about 60 per cent of such disequilibrium take two years to adjust; that is, about 30 per cent yearly adjustment. This interpretation is plausible given the potential comovement between tourism growth and environmental welfare in the short run. The temporary comovement as depicted by the positive and significant short-term coefficient ( $\Delta TG$ ) might be attributed to the effort of the tourism industry across the world to shift away from the environmental harmful practices; at least over the studied period. Therefore, the eventual switch to environment-friendly tourism gradually helps resorb the disequilibrium fuelled by previous unsustainable practices; hence reshaping the dynamics of tourism activities while making tourism growth and environment well-being members of a similar “club” that follows a common trend. With a lower speed of adjustment (-0.313) and an insignificant short-term effect, the annual output confirms this inference to some extent.

Unlike the full sample results, a mixed pattern emerges from the regional findings summarized in Tables 8 and 9. While the cointegration relationship is established across the different regions (negative and significant ECT); interesting to note is the finding that tourism growth exhibits a positive and significant long-term effect on the environment performance in America (for both data frequencies) and in Africa (based on biennial output). After controlling for cross section dependence, this finding remains robust for Europe but not for the rest of regions. Unsurprisingly, the dependency test based on Pesaran (2004) CD statistic is insignificant in these regions (Table 10), invalidating the CCE result for regional inference. From the PMG output, it could be inferred that regional characteristics of the main touristic attractions might explain differences in environment–tourism nexus across regions. In fact, contrary to Asia and Europe where tourism growth has a negative environmental impact, the top touristic attractions in Africa and America mainly comprise of natural reserves and/or parks, which, are important environmental assets due to their role in biodiversity protection and conservation. This interpretation is in line with the environmental enhancement hypothesis with empirical support from Anup and Parajuli (2014) who content that tourism expansion improves livelihood in a conservation locality in Nepal; possibly vindicating the positive externalities of nature-based tourism.

**Table 3** Countries by level of Tourism Growth Index (2006–2016)

High Tourism Growth	Medium tourism growth		Low tourism growth
Uruguay	Belgium	Macau	Morocco
Aruba	China	Rwanda	New Zealand
South Korea	Martinique	Sao Tome and Principe	Nigeria
Indonesia	Gabon	Latvia	India
British Virgin Islands	Democratic Republic of Congo	Panama	Montenegro
Moldova	Algeria	Finland	Austria
Lesotho	Seychelles	Guadeloupe	Uzbekistan
Mauritius	Uganda	Ghana	Kyrgyzstan
Vietnam	Nicaragua	Cape Verde	Comoros
Dominica	St Kitts and Nevis	Burkina Faso	Chad
Former Netherlands Antilles	Sri Lanka	France	Libya
Pakistan	Malaysia	Turkey	Cayman Islands
Slovakia	Colombia	Suriname	Maldives
Brazil	Ireland	Argentina	Cambodia
Israel	Togo	Mozambique	Philippines
Macedonia	Estonia	Luxembourg	US Virgin Islands
Venezuela	Niger	Kenya	Malta
Canada	Belarus	Sudan	Kiribati
Iceland	Singapore	Burundi	Portugal
Haiti	Benin	Belize	Australia
Malawi	Zambia	Botswana	Gambia
Poland	Bosnia-Herzegovina	Dominican Republic	Kuwait
Jordan	Denmark	Cuba	Bahrain
Anguilla	Tajikistan	St Lucia	Myanmar
Italy	Antigua and Barbuda	Guyana	Georgia
Yemen	Sweden	Saudi Arabia	Qatar
Guinea	Slovenia	Angola	Namibia
UK	Reunion	Ethiopia	Hong Kong
Mali	Congo	Japan	Ecuador
Sierra Leone	Vanuatu	Lithuania	Syria
Senegal	Fiji	Armenia	Hungary
Ukraine	Switzerland	Netherlands	Grenada
Guatemala	South Africa	Bangladesh	Spain
Cameroon	Zimbabwe	Romania	Czech Republic
Bolivia	Bahamas	Madagascar	Solomon Islands
Papua New Guinea	Azerbaijan	Serbia	Germany
Greece	Taiwan	Mongolia	Bermuda
United Arab Emirates	Iraq	USA	Tunisia
Honduras	Egypt	Tanzania	Thailand
Chile	Cyprus	Kazakhstan	Eswatini (former Swaziland)
Brunei	Norway	Mexico	Bulgaria
Iran	Barbados	Costa Rica	Peru

**Table 3** (continued)

High Tourism Growth	Medium tourism growth		Low tourism growth
Trinidad and Tobago	Puerto Rico	El Salvador	Paraguay
Central African Republic	St Vincent and the Grenadines	Jamaica	Croatia
Nepal	Laos	Albania	Côte d'Ivoire
Russian Federation	Oman		Lebanon

The high and low tourism growth countries are categorized as above 75th and 25th percentile of the TGI, respectively, while countries whose TG index fall between 25th and 75th percentiles are grouped as medium tourism growth countries. Important to note also is that some of the above countries were discarded from the analysis because of the lack of data on sustainability indices. Anguilla, Antigua and Barbuda, Aruba, Bahamas, Bahrain, Barbados, Belize, Bermuda, British Virgin Islands, Brunei, Cape Verde, Cayman Islands, Comoros, Dominica, Eswatini, Fiji, Former Netherlands Antilles, Grenada, Guadeloupe, Hong Kong, Kiribati, Macau, Maldives, Martinique, Puerto Rico, Reunion, Sao Tome and Principe, Seychelles, Solomon Islands, St Kitts and Nevis, St Lucia, St Vincent and the Grenadines, Suriname, US Virgin Islands and Vanuatu. Whereas, the following five countries are part of the empirical analysis although they do not have tourism growth data: Bhutan, Guinea-Bissau, Liberia, Mauritania and Turkmenistan

Arguably, this is not the case for Europe where the top touristic attractions include museum, well-built cities and monuments resulting from modernization and urbanization with their well-known detrimental effect on the environment. Alternatively, one may highlight the role of industrialization as the possible driver of the trade-off environment–tourism growth in Europe and Asia. Besides the irreversible characteristic of some environmental harmful technologies used in the development process across different economic sectors including tourism industry, the opportunity as well as replacement costs for switching to environment-friendly know-how remain very high for industrialized economies. Exception to this rule is the American region where the existence of huge natural reserves, particularly in the South America, has the potential to mitigate the environment cost from the highly industrialized North America; possibly resulting in the positive long-term association between tourism growth and environment welfare.

For less industrialized region such as Asia where many economies are still emerging, the relatively low level of urbanization and industrialization, although still costly for the environment, may justify their limited exposure to environmental harmful practices, particularly in the tourism industry. In effect, Zang and Liu (2019) analysed the joint dynamic between tourism growth, non-renewable energy and pollution across Southeast Asia countries and reported no causal effect of tourism development on CO<sub>2</sub> emissions. According to these, authors, non-renewable energy rather than tourism expansion must be blamed for the environmental degradation in these countries given the strong causality from non-renewable energy to CO<sub>2</sub> emissions. The high speed of adjustment for Asia (-0.724) possibly points to its limited switching cost to eco-friendly activities; suggesting that tourism development and environment performance in Asia are likely to move away faster from their disequilibrium positions than Europe to a long-term common steady state.

Considering that environmental sustainability might be influenced by economic and social factors, the analysis proceeds further by categorizing the countries in terms of the

**Table 4** Countries by level of environmental sustainability (2006–2016)

High environmental sustainability	Medium environmental sustainability	Low environmental sustainability
Zambia	Guatemala	Azerbaijan
Lesotho	El Salvador	Armenia
Ethiopia	Congo	Switzerland
Central African Republic	Mauritania	Portugal
Rwanda	Dominican Republic	Venezuela
Uganda	Vietnam	Mauritius
Gambia	Honduras	Hungary
Kenya	Gabon	Tunisia
Burundi	Montenegro	Latvia
Malawi	Myanmar	Bulgaria
Mozambique	Albania	Lebanon
Guinea	Colombia	Slovak Republic
Burkina Faso	Indonesia	Serbia
Nepal	Jamaica	Chile
Chad	Guyana	Bolivia
Togo	Kyrgyz Republic	Italy
Tanzania	Georgia	Uruguay
Madagascar	Papua New Guinea	Spain
Zimbabwe	Paraguay	Ukraine
Cameroon	Botswana	Algeria
Guinea-Bissau	Pakistan	China
Niger	Cuba	Slovenia
Sierra Leone	Sudan	Greece
Congo Democratic Rep	Namibia	Lithuania
Mali	Panama	Argentina
Liberia	India	South Africa
Cambodia	Peru	Turkey
Ghana	Brazil	Poland
Philippines	Bhutan	Malta
Senegal	Ecuador	UK
Cote d'Ivoire	Bangladesh	Malaysia
Sri Lanka	Croatia	Iraq
Laos	Uzbekistan	Austria
Nicaragua	Macedonia	Bosnia-Herzegovina
Nigeria	Moldova	Syria
Tajikistan	Korea, North	
Benin	Morocco	

**Table 4** (continued)

High environmental sustainability	Medium environmental sustainability	Low environmental sustainability
Costa Rica	Romania	Qatar
Angola	Mexico	Turkmenistan
Haiti	Thailand	

The high and low environmental sustainability countries are categorized as above 75th and 25th percentile of the EVWB, respectively, while countries whose EVWB fall between 25th and 75th percentiles are grouped as medium environmental sustainability countries. In addition, some of the above countries were excluded from the analysis because of the lack of data on tourism growth. Bhutan, Guinea-Bissau, North Korea, Liberia, Mauritania and Turkmenistan

convergence potential of their environment performance. To this end, we use the convergence club technique proposed by Phillips and Su<sup>5</sup> (2007) which detects three convergence clusters with the possibility of the last two clusters to form a single club. The two mega clubs displayed in Table 12 in the Appendix are obtained from the club convergence hypothesis stipulating that countries that move from the environment disequilibrium position to their club-specific steady state path belong to the same cluster.

Surprisingly, the first cluster (Club 1) is comprised of countries with relatively low social and economic profiles, whereas the second cluster (Club 2) is made up of countries with comparatively high social and economic characteristics. This observation gives rise to the question whether social and economic factors play a role in driving the joint dynamics between environment and tourism, which the last two columns of Tables 8, 9 and 10 endeavour to answer.

In both clusters, environment and tourism growth converge together from their disequilibrium positions but the long-term environmental effect of tourism growth is consistently negative in the low social and economic cluster across empirical scenarios. In the high social and economic cluster, the environmental effect is either positive or negative depending on the estimation strategy. Likewise, the cluster with high social and economic profile appears to adjust quicker to short-term disequilibrium than the low social and economic cluster. This could suggest that countries from the second cluster are likely to rapidly curb the negative environmental effect of human activities due to their social and economic externalities partly derived from the improvement of the tourism sector. This is in line with Brahmašre and Lee (2017) who found that tourism expansion reduces the environmental deterioration, possibly through skill improvement in environmental friendly practices, in managing and controlling waste issue, pest control, habitat improvement, etc.

<sup>5</sup> Phillips and Sul (2007) club convergence test is built on the intuition that  $N$  cross sections are likely to follow a common path to the steady state at some point in time, regardless of whether they are near the steady state or in transition. Thus convergence pattern of a group of countries is framed as a nonlinear time varying factor model allowing for various time paths as well as individual heterogeneity. Its particularity lies in the possibility to ensure endogenous determination of convergence clubs rather than exogenous a priori grouping as implemented in alternative approaches. Technical details on this test can be found in Apergis et al. (2018).

**Table 5** Panel stationarity test (IPS unit root)

	Level	First Difference	Decision
<i>Panel A. All countries</i>			
TG	- 0.800	- 2.741***	I(1)
EVWB	1.528	- 2.964***	I(1)
<i>Panel B. Africa</i>			
TG	- 1.830	- 2.762***	I(1)
EVWB	- 1.678	- 2.281***	I(1)
<i>Panel C. America</i>			
TG	- 1.795	- 2.610***	I(1)
EVWB	- 1.416	- 1.698	I(2)
<i>Panel D. Asia</i>			
TG	- 1.726	- 2.502***	I(1)
EVWB	- 1.572	- 2.388***	I(1)
<i>Panel E. Europe</i>			
TG	- 1.864	- 2.328***	I(1)
EVWB	- 1.176	- 2.783***	I(1)

\*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ . In panel A, the reported figures are the z-tilde-bar statistics, which correspond to the large N scenario (that is N going to infinity). However, Panels B, C, D and E report the t-bar statistics associated to relatively small N

This heterogeneity in the correction speed is further observed at the individual country level as displayed in Table 11. The first panel of Table 11 displays 76 out of the full sample of 148 countries, most of which being from Africa, Asia and America, which show possible convergence between environment and tourism as inferred from their negative and significant ECTs. Expectedly, the yearly speed of adjustment across countries is in general, less than one in absolute value and this indicates less than 100% disequilibrium correction per year. A few exceptions to this comprise of Cameroon, Nepal and Philippines where the speed of adjustment is greater than one. Although uncommon in the cointegration literature, these exceptions are often associated with oscillating convergence also known as dynamic convergence towards a common path.

For the rest of the countries (68 in total), there is no evidence of long-term relationship between tourism and environment with the exception of Saudi Arabia, Sri Lanka, Uganda and Venezuela where both variables are indeed divergent as evidenced by the positive and significant ECTs (Panel B of Table 11). One possible explanation might be the relative insignificance of the tourism industry in determining the environmental sustainability in



**Table 6** Panel cointegration tests

	All countries	Africa	America	Asia	Europe
<i>Panel A. Kao cointegration test. H0: no cointegration; Ha: All countries are cointegrated</i>					
Modified Dickey–Fuller t	8.404*** (0.0000)	4.126*** (0.0000)	3.609*** (0.0002)	4.151*** (0.0000)	4.403*** (0.0000)
Dickey–Fuller t	5.296*** (0.0000)	2.351*** (0.0094)	1.792** (0.0366)	2.007** (0.0224)	3.760*** (0.0000)
Augmented Dickey–Fuller t	– 2.199** (0.0139)	– 2.556*** (0.0053)	– 2.332*** (0.0098)	– 1.190 (0.1169)	0.519 (0.3018)
Unadjusted Modified Dickey–Fuller t	0.392 (0.3475)	– 0.573 (0.28334)	0.1536 (0.4390)	– 0.425 (0.3354)	1.658** (0.0487)
Adjusted Dickey–Fuller t	– 4.5976*** (0.0000)	– 2.991*** (0.0014)	– 2.70*** (0.0035)	– 3.5583*** (0.0002)	0.203 (0.4196)
<i>Panel B. Pedroni Cointegration Test. H0: no cointegration; Ha: All countries are cointegrated</i>					
	All countries	Africa	America	Asia	Europe
Modified Phillips–Perron t	9.552*** (0.0000)	3.973*** (0.0000)	4.035*** (0.0000)	4.639*** (0.0000)	5.598*** (0.0000)
Phillips–Perron t	– 19.487*** (0.0000)	– 7.649*** (0.0000)	– 4.4137*** (0.0000)	– 12.048*** (0.0000)	– 13.448*** (0.0000)
Augmented Dickey–Fuller t	– 58.791*** (0.0000)	– 18.315*** (0.0000)	– 15.226*** (0.0000)	– 53.490*** (0.0000)	– 30.170*** (0.0000)
<i>Panel C. Westerlund Cointegration tests. H0: no cointegration; Ha: Some (Ha1) or all (Ha2) countries are cointegrated</i>					
	All countries	Africa	America	Asia	Europe
Variance ratio (Ha1)	6.111 *** (0.0000)	1.155 (0.1241)	2.330 *** (0.0099)	2.026** (0.0214)	5.885*** (0.0000)
Variance ratio (Ha2)	1.7681*** (0.0000)	– 0.771 (0.2203)	0.147 (0.4417)	– 0.0117 (0.4953)	3.418*** (0.0003)

\*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ . The reported figures are the test statistics with p-values in brackets

these countries. It could be inferred that environmental sustainability in these countries is more subject to non-tourism factors (Table 12).

Overall, it appears that the environmental effect of tourism growth is negative for the full sample, positive in some regions and neutral in other countries. The convergence being interpreted as the existence of a cointegration relationship, the empirical findings suggest that environment performance and tourism development are convergent not only in the full sample, but also across different regions and in the majority of individual countries. In addition, countries with comparable socioeconomic features tend to form a convergence club in terms of their environment performance; convergence club within which the joint dynamics between environment and tourism appear different. In line with previous studies, this possibly suggests that social and economic factors are likely to influence the environment–tourism nexus. However, the parsimonious requirement due to the limited time horizon could not allow the inclusion of controlled variables; resulting in possible omission variable bias, which can be addressed when new environmental sustainability index data

**Table 7** Long- and short-term effects of tourism growth on environmental sustainability (all countries)

	Biennial data-based estimates			Annual data-based estimates		
	Model 1 PMG	Model 2 MG	Model 3 DFE	Model 4 PMG	Model 5 MG	Model 6 DFE
<i>Panel A. Long term</i>						
TG	- 0.201*** (0.00276)	- 0.471 (0.893)	- 0.112** (0.0556)	- 0.123*** (0.019)	- 0.660 (0.438)	- 0.049** (0.059)
<i>Panel B. Short run</i>						
ECT	- 0.595*** (0.0565)	- 0.683*** (0.128)	- 0.539*** (0.0374)	- 0.313*** (0.024)	- 0.410*** (0.029)	- 0.270*** (0.020)
$\Delta$ TG	0.216** (0.0961)	- 0.00789 (0.222)	0.0417* (0.0230)	- 0.024 (0.047)	0.010 (0.061)	- 0.004 (0.0140)
Constant	3.066*** (0.338)	3.454*** (0.600)	2.670*** (0.1844)	1.654*** (0.3141)	2.002*** (0.190)	1.338*** (0.983)
Observations	740	740	740	1480	1480	1480
Hausman test				0.02 Pr = 0.8803)		

Standard errors in parentheses. \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ . Hausman test compares Model 1 and Model 2 under the null hypothesis that the estimated coefficients are consistent under Model 1 (pooled mean group). This test is chi squared distributed

become available. Moreover, in dynamic panel framework, the endogeneity bias is likely to arise from the inclusion of lagged dependent variable as regressor, which, may result in correlation between dependent variable and the residuals known as endogeneity. Likewise, it is reasonable to argue that environmental performance may determine tourism growth, that is, the possibility of feedback effect, which represents another source of endogeneity. Therefore, the use of alternative empirical set-up that accounts for endogeneity would shed further light on the tourism–environment nexus.

## 6 Conclusion and policy implications

This paper is an attempt to characterize the dynamic relationship between tourism growth and environmental sustainability. The emergence of ecotourism is gradually shaping the tourism industry worldwide and this offers the rationale to conjecture a possible cointegration relationship between tourism development and environmental performance interpreted as convergence. To test this assumption, the study relies on biennial time series data for

**Table 8** PMG estimates of the environmental effects of tourism growth: regional and cluster comparison based on biennial data

	Geographical region				Socioeconomic cluster	
	Africa	America	Asia	Europe	Low cluster	High cluster
<i>Panel A. Long-term</i>						
TG	0.158*** (0.00276)	0.573*** (0.0484)	- 0.199*** (0.0027)	- 0.708*** (0.0301)	- 0.667*** (0.0000)	0.126*** (0.0000)
<i>Panel B. Short run</i>						
ECT	- 0.577*** (0.0823)	- 0.3081** (0.1241)	- 0.724*** (0.1499)	- 0.334*** (0.0744)	- 0.353*** (0.0000)	- 0.619*** (0.0000)
$\Delta$ TG	0.1224 (0.2059)	0.0794 (0.222)	0.260 (0.1754)	0.217 (0.1853)	0.230* (0.1383)	0.1234 (0.1240)
Constant	3.879*** (0.5929)	1.609** (0.6025)	3.477** (0.8878)	1.452*** (0.2938)	2.151*** (0.3963)	2.282*** (0.3686)
Observations	205	125	180	215	440	300

Standard errors in parentheses. \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$

a panel of 148 countries spanning the period from 2006 to 2016 and makes use of panel cointegration techniques.

The empirical results reveal a negative long-term effect of tourism growth on the environmental welfare over the past decade; suggesting a trade-off between tourism activities and environment performance. This trade-off is consistent across regional panels, namely Asian and Europe with the exception of America where there is indeed a supportive evidence of a positive long-term relationship between tourism growth and environmental welfare. The level of industrialization/urbanization and its associated environmental consequences might explain the trade-off effect observed from Asia and Europe. Conversely, the positive environmental effect for America is consistent with the conjecture that the industrialization/urbanization induced pollution particularly from the North America might be mitigated by the environmental benefits derived from their top touristic attractions that mainly comprise of natural reserves and parks. However, the long-term tourism effect on environmental performance in Africa remains controversial across empirical scenarios (positive, negative or insignificant). Thus, the sluggish development performance in this part of the world might have helped conserve natural reserves and biodiversity that is favourable to both ecotourism and environmental sustainability. Similarly, the poor socioeconomic status of this region is likely to restrict the switching ability to environment-friendly tourism practices leading to environmental degradation. These results point to the existence of significant unsustainability practices in the world tourism industries, although less pronounced in Africa and America.

**Table 9** PMG estimates of the environmental effects of tourism growth: regional and cluster comparison based on annual data

	Geographical region				Socioeconomic cluster	
	Africa	America	Asia	Europe	Low cluster	High cluster
<i>Panel A. Long-term</i>						
TG	- 0.115*** (0.028)	1.620*** (0.204)	- 0.144*** (0.044)	- 0.110*** (0.0301)	- 0.227*** (0.032)	- 0.100*** (0.026)
<i>Panel B. Short run</i>						
ECT	- 0.411*** (0.040)	- 0.178** (0.1241)	- 0.385*** (0.052)	- 0.195*** (0.047)	- 0.293*** (0.029)	- 0.329*** (0.040)
ΔTG	- 0.065 (0.095)	- 0.186** (0.080)	- 0.079 (0.086)	0.020 (0.101)	- 0.045 (0.068)	0.028 (0.058)
Constant	2.751*** (0.288)	0.625** (0.228)	1.699*** (0.333)	0.809*** (0.162)	1.894*** (0.198)	1.159*** (0.138)
Observations	410	250	360	430	880	600

Standard errors in parentheses. \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$

**Table 10** CCE estimates of the environmental effects of tourism growth

	World	Africa	America	Asia	Europe	Low cluster	High cluster
<i>Panel A. Long-term</i>							
TG	- 0.972* (0.570)	0.103 (0.340)	- 0.215 (0.909)	1.029 (0.855)	- 0.765** (0.327)	- 1.334* (0.799)	0.157 (0.450)
<i>Panel B. Short run</i>							
ECT	- 0.372*** (0.030)	- 0.456*** (0.046)	- 0.331*** (0.061)	- 0.463*** (0.068)	- 0.720*** (0.084)	- 0.307*** (0.040)	- 0.398*** (0.040)
ΔTG	0.015 (0.062)	- 0.096 (0.100)	- 0.095 (0.128)	0.083 (0.158)	0.155 (0.148)	- 0.037 (0.089)	0.083 (0.081)
Observations	1480	410	250	360	430	880	600
CD Test	10.91 (Pr=0.000)	1.44 (Pr=0.149)	0.32 (Pr=0.748)	- 0.75 (Pr=0.456)	19.47 (Pr=0.000)	9.06 (Pr=0.000)	0.97 (Pr=0.332)

Standard errors in parentheses. \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ . Figures displayed are MG estimates from the CCE model using annual data. CD is the cross-sectional dependence test

**Table 11** Environmental sustainability and tourism growth linkage by country

Countries	Yearly speed of adjustment (ECT)	Countries	Yearly speed of adjustment (ECT)
<i>Panel A. Convergent relationship</i>			
Albania	- 0.609***	Malawi	- 0.595***
Armenia	- 0.396*	Malaysia	- 0.4675**
Azerbaijan	- 0.255***	Mali	- 0.254***
Bangladesh	- 0.3215**	Moldova	- 0.2565***
Belarus	- 0.5265**	Mongolia	- 0.623***
Benin	- 0.461**	Montenegro	- 0.434***
Bolivia	- 0.4835**	Morocco	- 0.506***
Bosnia-Herzegovina	- 0.907**	Mozambique	- 0.2955**
Burkina Faso	- 0.476**	Myanmar	- 0.491*
Burundi	- 0.097***	Namibia	- 0.45**
Cameroon	- 1.8785***	Nepal	- 1.017***
Chad	- 0.11*	New Zealand	- 0.792***
Chile	- 0.635**	Nigeria	- 0.8205***
China	- 0.1435*	Norway	- 0.419***
Congo	- 0.6605***	Oman	- 0.581***
Cuba	- 0.629***	Pakistan	- 0.3455*
Czech Republic	- 0.0437***	Panama	- 0.4915***
Dominican Republic	- 0.296*	Paraguay	- 0.3595*
Ecuador	- 0.2525**	Peru	- 0.112**
Estonia	- 0.604***	Philippines	- 1.398***
Finland	- 0.1325***	Portugal	- 0.1**
France	- 0.152***	Qatar	- 0.7485***
Gabon	- 0.3395**	Russia	- 0.9295***
Georgia	- 0.4415**	Senegal	- 0.5235*
Honduras	- 0.2635**	Serbia	- 0.0975**
Iceland	- 0.389***	Singapore	- 0.4015**
Indonesia	- 0.929***	South Africa	- 0.4225***
Iran	- 0.292*	Sweden	- 0.6025***
Jamaica	- 0.326*	Tajikistan	- 0.9505***
Japan	- 0.697**	Thailand	- 0.6255***
Kazakhstan	- 0.509**	Togo	- 0.6975***
Kenya	- 0.6455***	Trinidad and Tobago	- 0.266*
Kyrgyz Republic	- 0.8985***	Tunisia	- 0.333*
Laos	- 0.3245***	Turkey	- 0.661***
Lesotho	- 0.076***	United Arab Emirates	- 0.257***
Libya	- 0.4545*	Uruguay	- 0.3835***
Lithuania	- 0.882***	Uzbekistan	- 0.6235***
Luxembourg	- 0.3255***	Vietnam	- 0.36**
<i>Panel B. Divergent relationship</i>			
Saudi Arabia	0.9615***		

**Table 11** (continued)

Countries	Yearly speed of adjustment (ECT)	Countries	Yearly speed of adjustment (ECT)
Sri Lanka	0.8345*		
Uganda	0.175*		
Venezuela	0.4575**		

\*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ . Given the biennial frequency, the figures displayed are obtained by dividing the estimated ECT by 2

Furthermore, the presence of cointegration between environment performance and tourism growth in the full sample, across all the regions and in the majority of individual countries, may suggest the likelihood of both variables to move away from their respective disequilibrium positions to a common equilibrium path. However, the movement of these variables away from their instability locations and referred to as disequilibrium correction occurs at different speeds depending not only on regional/cluster heterogeneities but also on the estimation technique. High socioeconomic cluster tends to adjust faster than the poor one irrespective of the empirical strategy. After controlling for cross section dependence, the fastest adjustment occurs in Europe followed by Asia; possibly indicating their moderate switching cost to eco-friendly tourism practices due to high technology and improved socioeconomic indicators. On the other hand, the low correction speed from Africa might reveal the relatively high opportunity and replacement costs of some environmental harmful tourism practices due to their poor socioeconomic conditions.

The same heterogeneity pattern emerges from individual country results with a few cases of divergence (particularly in four countries) and the evidence of no equilibrium relationship between environment well-being and tourism growth for 68 countries. The heterogeneity of the environment–tourism nexus is further evidenced across socioeconomic clusters with positive (negative) environmental impact of tourism in the high (low) social and economic cluster. These findings point to socioeconomic factors as important covariates in analysing the dynamic relationship between tourism growth and environment performance. In fact, the pollution induced by tourism activities is not the only environmental determinant while tourism growth is not exclusively driven by the environmental factor as assumed in our empirical setup for the sake of parsimony given the limited time series. Further investigations that account for socioeconomic determinants of both tourism growth and environment sustainability are open for future research. Moreover, some studies have substantiated the significance of nonlinearities in driving the effect of tourism development on environmental degradation (Ehigiamusoe, 2020b; Zhang and Liu, 2019). Though nonlinearity could not be accommodated by the empirical setup of this study, a nonlinear analysis would shed further light on the net environmental effect of tourism expansion.

**Table 12** Convergence clubs in environment performance

Club 1 Countries		Club 2 Countries	
Albania	Madagascar	Algeria	Lebanon
Angola	Malawi	Argentina	Libya
Austria	Mali	Armenia	Lithuania
Bangladesh	Malta	Australia	Luxembourg
Benin	Mauritius	Azerbaijan	Malaysia
Brazil	Mexico	Belarus	Mongolia
Bulgaria	Moldova	Belgium	Myanmar
Burkina Faso	Montenegro	Bolivia	Netherlands
Burundi	Morocco	Bosnia-Herzegovina	New Zealand
Cambodia	Mozambique	Botswana	Oman
Cameroon	Namibia	Canada	Panama
Central African Republic	Nepal	Chile	Papua New Guinea
Chad	Nicaragua	China	Peru
Colombia	Niger	Czech Republic	Poland
Congo	Nigeria	Ecuador	Qatar
Congo Democratic Rep	Norway	Estonia	Russia
Costa Rica	Pakistan	Finland	Saudi Arabia
Cote d'Ivoire	Paraguay	France	Singapore
Croatia	Philippines	Georgia	Sweden
Cuba	Portugal	Germany	Taiwan
Cyprus	Romania	Guyana	Thailand
Denmark	Rwanda	Iceland	Trinidad and Tobago
Dominican Republic	Senegal	Iran	Tunisia
Egypt	Serbia	Iraq	Turkey
El Salvador	Sierra Leone	Ireland	United Arab Emirates
Ethiopia	Slovak Republic	Israel	USA
Gabon	Slovenia	Japan	Vietnam
Gambia	South Africa	Jordan	Yemen
Ghana	Spain	Kazakhstan	Taiwan
Greece	Sri Lanka	Korea, South	Thailand
Guatemala	Sudan	Kuwait	Trinidad and Tobago
Guinea	Switzerland	Kyrgyz Republic	
Haiti	Syria		
Honduras	Tajikistan		
Hungary	Tanzania		
India	Togo		
Indonesia	Uganda		
Italy	Ukraine		
Jamaica	UK		
Kenya	Uruguay		

**Table 12** (continued)

Club 1 Countries	Club 2 Countries
Laos	Uzbekistan
Latvia	Venezuela
Lesotho	Zambia
Macedonia	Zimbabwe

Despite the caution in interpreting the empirical findings called upon by the above-mentioned limitations, our results bear important policy implications. Particularly, it can be inferred that unsustainable practices in tourism industry put harmful pressure on environmental assets while ecotourism has important environmental enhancement effect. Accordingly, policies geared towards reducing the adverse environmental effects should be integrated with countries tourism management strategies to enable the shift to sustainable tourism development. This leads to the conclusion that a better approach to set the goal for tourism development would be to target nature tourism rather than traditional targets such as number of visitors, income stream and employment. This could be achieved through increasing environment awareness with the potential to correct attitudes, intentions and actions of tourists with positive externalities on the nature. Similarly, improving eco-friendly training skills for tourism practitioners can boost the development of sustainable tourism by providing expert assistance to stakeholders in achieving sustainable development planning, management, marketing and implementation. Finally, emphasizing long-term switching benefits in public dialogs and promoting continuous development of natural touristic attractions can contribute to shaping the future of the tourism industry towards ecotourism.



## Appendix 1: Regional tourism growth

Exhibit 1: Tourism Growth Index in Africa: 2006-2016

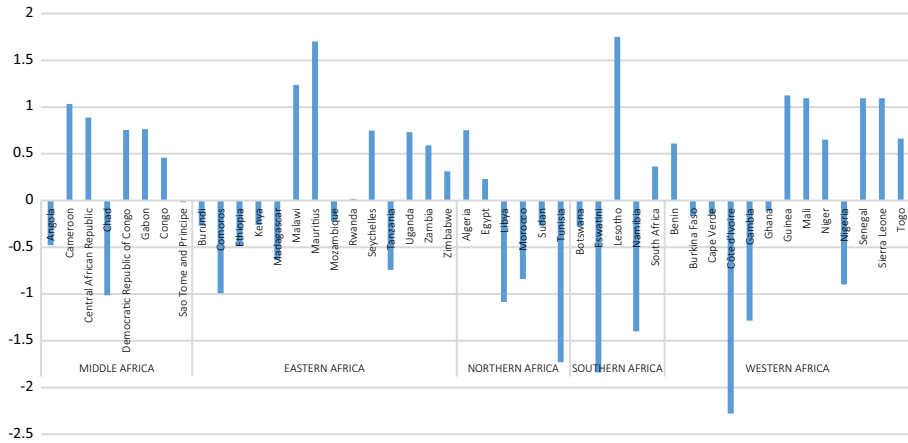


Exhibit 2: Tourism Growth Index in America: 2006-2016

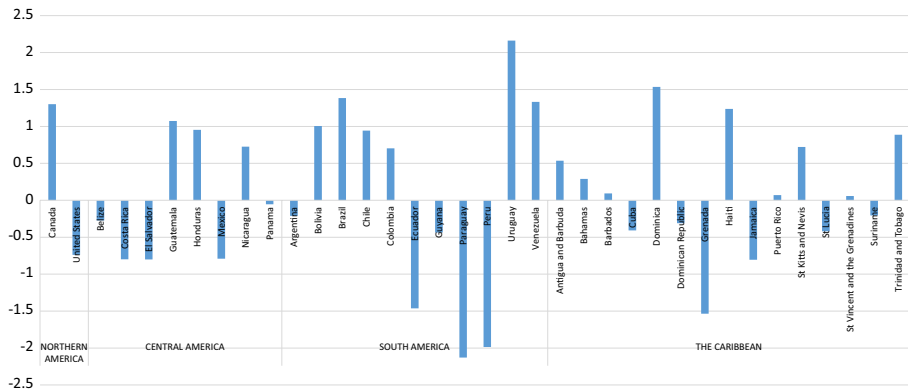


Exhibit 3: Tourism Growth Index in Asia: 2006-2016

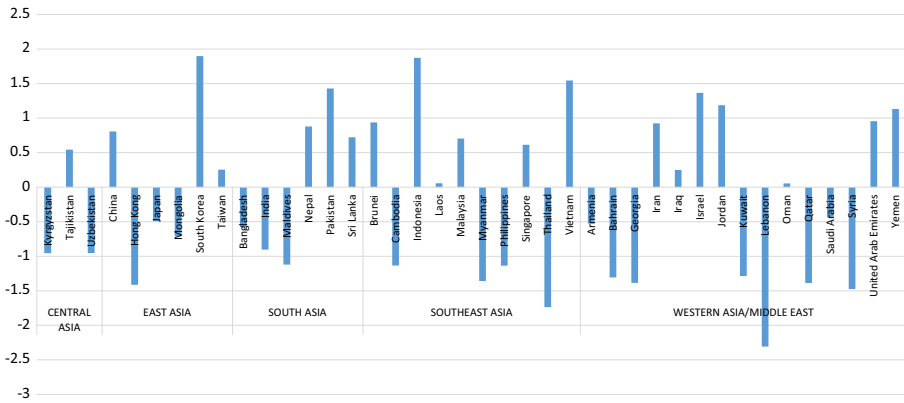
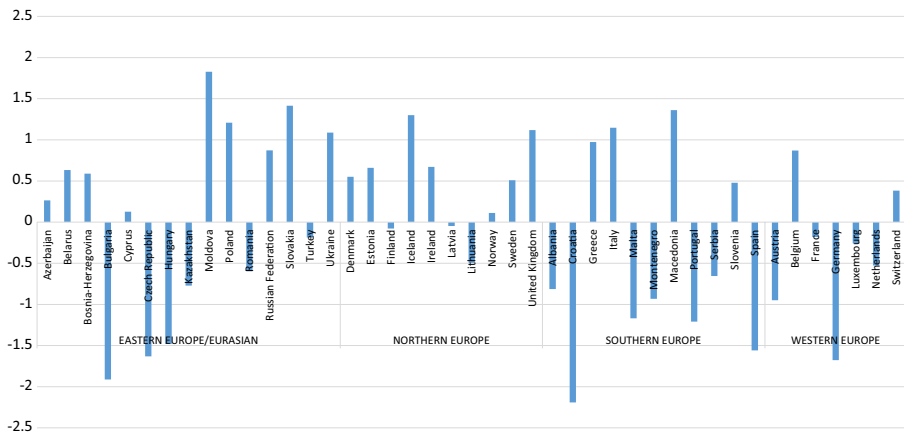
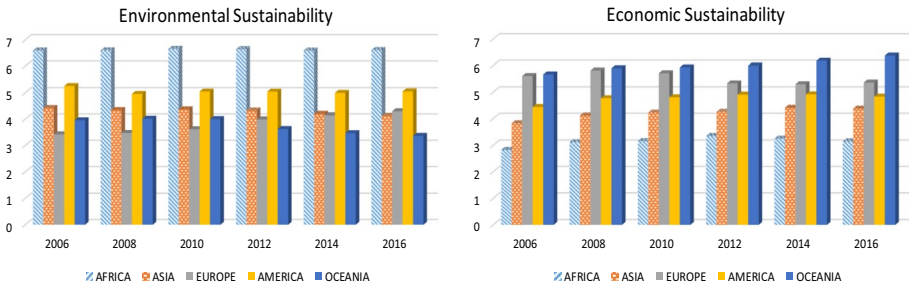


Exhibit 4: Tourism Growth Index in Europe: 2006-2016



## Appendix 2: Sustainability indices across regions



## Appendix 3: Technical details on PCA

The PCA as introduced by Jolliffe (2002) consists of decomposing each observation from a sample into principal components.

Let  $X$  be a vector of  $p$  variables on a sample of  $n$  observations:

$$X = (x_1, x_2, \dots, x_p)$$

The first principal component of the sample is defined by the linear transformation:

$$z_1 \equiv a_1^T X = \sum_{i=1}^p a_{i1} x_i$$

where the vector  $a_1 = (a_{11}, a_{21}, \dots, a_{p1})$  is such that  $Var(z_1)$  is *max imum*.

Similarly, the  $k$ th principal component of the sample is defined by the linear transformation:

$$z_k \equiv a_k^T X = \sum_{i=1}^p a_{ik} x_i \quad k = 1, \dots, p$$

where the vector  $a_k = (a_{1k}, a_{2k}, \dots, a_{pk})$  is such that  $Var(z_k)$  is *max imum*. subject to

$$\left\{ \begin{array}{l} cov[z_k, z_l] = 0 \text{ for } k > l \geq 1 \\ \text{and} \\ a_k^T a_k = 1 \end{array} \right.$$

It is shown that  $cov[z_1, z_2] = a_1^T S a_2 = \lambda_1 a_1^T a_2$ . where  $S$  is the covariance matrix and  $\lambda_1$  the largest eigenvalue of  $S$ .

In general, the  $k$ th eigenvalue of  $S$  is the variance of the  $k$ th principal component; that is:  $Var[z_k] = a_k^T S a_k = \lambda_k$ .

Therefore, the  $k$ th principal component retains the  $k$ th greatest fraction of the variation in the sample.

For data compression, PCA reduces the dimensionality of the data from  $p$  to  $m$  by approximating  $X \cong X^m = Z^m A^m T$ .

Where.

- $Z^m$  is the  $n \times m$  portion of  $Z$  and  $A^m$  is the  $p \times m$  portion of  $A$
- $Z = A^T X$  and  $A$  being an orthogonal  $p \times p$  matrix.
- $Z = (z_1, z_2, \dots, z_p)$  and  $X$  as defined previously

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