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Tourism Development and Air Pollution in Caribbean SIDs: A Bootstrap Panel Granger Causality Analysis

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Abstract

This paper investigates the possibility of Granger causality between tourism development and air pollution in twelve Caribbean small island developing states (SIDs) over the period 1995-2017 in a panel-based model that both allows for the assessment of causality in countries with cross-sectional dependency and heterogeneity and avoids the problem of incorrect specification associated with conventional panel unit root and cointegration tests. The empirical results indicate bidirectional causality between tourism and air pollution for Barbados, Dominican Republic, Jamaica, St. Lucia, and Trinidad and Tobago; unidirectional causality running from tourism to air pollution in Antigua and Barbuda, Cuba, and Guyana; reverse causality from air pollution to tourism in The Bahamas, British Virgin Islands and Haiti, while no causality is found for St. Kitts and Nevis. Our empirical findings provide important policy implications for the Caribbean countries being studied.

Keywords

Tourism Development, Air Pollution, Bootstrap Panel Data Granger Causality, Caribbean SIDs

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Introduction

Numerous studies point out that environmental quality is one of the most important factors influencing customers' choice of holiday destination . It also affects their travel experiences as well as their aesthetic judgement of destinations (Mutinda and Mayaka; 2012; Zhang et al., 2015; Becken et al. 2017; Hoogendoorn and Fitchett, 2018). Located between the Equator and the Tropic of Cancer, the Caribbean, with its scenic terrestrial and marine assets and favorable climate, is one of the most sought-after tourist destinations in the world . International tourist arrivals to Caribbean destinations increased from 11.4 million in 1990 to 17.1 million in 2000, and from 23.9 million in 2015 to 36.6 in 2017 (UNWTO 2018). According to statistical data from the World Travel and Tourism Council (WTTC, 2018), the Caribbean has the most tourism-intensive economy (i.e. tourism represents the greatest proportion of the regional economy) among the 12 regions ranked by the WTTC. In 2017, tourism in the Caribbean represented 14% of Gross Domestic Product (GDP), 13% of employment (2.2 million jobs), 12% of investment and 17% of exports.

In addition to its remarkable contribution to the economy, tourism in the Caribbean also has collateral effects, especially from an environmental point of view, that are seriously compromising the quality and sustainability of the tourism product and overall economic development. Specifically, the massive influx of tourists every year, often to a relatively small area, and the associated services (facilities, attractions, transportation and accommodation) that are provided and utilized to aid in their movement, frequently cause significant environmental degradation through emitting greenhouse gases, mainly carbon dioxide (CO_2), into the environment[1]. These are emissions that may reduce the future attractiveness of the tourism product in the environmental hotspots.

Although, substantial work has been done on the impacts of tourism on the environment (Scott et al., 2012), studies that have attempted to empirically analyze the impacts of air pollution on tourism, and of the causal relationship between these variables, still remain very scarce, particularly for small island developing states (SIDs). The skewed emphasis has amplified the incomplete understanding of the tourism-environmental pollution relationship. The aim of this paper is to contribute to the literature by identifying the Granger-causality between tourism development and air pollution in the Caribbean, using country specific analysis.

Arguably, the Caribbean SIDs constitute an ideal case study for the issue at hand, being the most tourism dependent and the most sought-after destination in the world. Given the economic importance of the tourism sector on the Caribbean economy,

1 The world's tourism industry is estimated to create about 5% of total GHG emissions (1302 Mt CO2), primarily from tourist transport (75%), accommodation (21%, mainly from air-conditioning and heating systems of all emissions) and tourist activities (3%), as these involve energy consumption mainly from burning fossil fuels (UNWTO, 2007).

a better understanding of the tourism-environmental quality nexus is vital to design sustainable tourism policies, considering that the tourism product is negatively affected by global warming and climate change.

Contrary to widely held perceptions, the Caribbean is not a homogenous group of countries. The nations within the Caribbean archipelago vary greatly in their social, political, cultural and economic performance, in the number of international tourist arrivals, in their respective tourism and environmental conservation policies, and in their resilience to shocks. This suggests that the tourism-air pollution relationships may be country-specific. Dependence among the Caribbean nations is inevitable due to current prevalence towards globalization and its accompanying trade liberalization between nations and within economic blocks. Even though there is strong dependence between the countries of the region, it is well known that each one controls its own growth trajectory. This makes it imperative to control for cross-country heterogeneity when initiating an empirical modeling strategy, in order to avoid the problem of cross-sectional dependence. With this in mind, we used, as an investigative technique, the country-specific bootstrap panel Granger causality approach proposed by Konya (2006) to untangle the dynamic and causal nexus between tourism development and air pollution in a panel of twelve Caribbean SIDs. Unlike traditional panel causality techniques, this methodology allows for simultaneous examination of cross-sectional dependence and cross-country heterogeneity, issues which have been shown to induce bias estimates[2].

Our study makes three unique contributions to the existing tourism literature. First, the analysis focuses on the Caribbean SIDs. Most of them have not been analyzed from this perspective before. They are all small island developing economies with very fragile ecosytems who are net importers of food, petroleum products and raw materials, and who are very open to international trade. The economies rely heavily on one or two industries: tourism in the services sector, energy-related products in the manufacturing sector, and bananas or sugar in the agricultural sector. Their growth is very susceptible to external forces including weather, changes in global commodity prices and the performance of their trade partners. Due these similarities, the data used were characterized by cross-sectional dependence, and the application of the methodology suggested by Konya (2006) made correct inference on causalities in these countries possible. To the best of our knowledge, this is the first study to apply a bootstrap panel Granger causality testing approach to the relationship between tourism development and air pollution or environmental quality in the Caribbean SIDs.

2 Recent experience in economic dynamics show that shocks in a country may spillover to other countries through international trade and economic and financial integration. This situation is called cross-section dependence, and it is a basic feature among the Caribbean countries. Pesaran (2006) proved that ignoring cross-section dependency in panel analysis of countries with high degree of integration leads to substantial bias and size distortions which results in misleading inferences.

Second, and in contrast to much of the literature which ignores cross-sectional dependence and cross-country heterogeneity dynamics in their analysis, this study follows a systematic modeling strategy in untangling causal linkages between the variables under concern. We separately test for both cross-section dependence and cross-country heterogeneity using new and more robust econometric techniques which can account for these situations instead of assuming the existence of these dynamics in our panel data set. We contribute to the existing literature by jointly addressing the two concerns.

Third, this research gains additional significance in light of the growing concern about climate change and global warming and can also be seen as adding another dimension to the empirical research on the tourism-environmental quality nexus. The findings from this analysis, though representing just the tip of an iceberg, could be useful in formulating tourism policies specifically tailored to the Caribbean, thereby addressing environmental issues that are indigenous to countries in the region.

The balance of the paper is organized as follows: Section 2 provides a review of the relevant literature on the nexus of tourism development and air pollution. Section 3 discusses the methodology and data used in the analysis, while Section 4 presents the empirical results and policy implications from the empirical findings. Section 5 provides concluding remarks.

Review of the Literature

As the travel and tourism industry has grown and attained higher levels of importance over the last several decades, its engagement with economic, socio-cultural, and environmental issues has garnered more attention in public and academic circles. Accordingly, the number of theoretical and empirical studies that look into this relationship has increased. The bulk of the theoretical analyses implicate CO_2 emissions as a function of tourism activities (Pigram, 1980; Becken and Simmons, 2002; Gossling, 2002; Becken et al., 2003; Nepal, 2008; Tovar and Lockwood, 2008; Lee and Brahmasrene, 2013). Specifically, these studies argue that as the tourism sector develops it will rely increasingly on energy, mainly fossil fuels, which emits a significant amount of CO_2 emissions into the atmosphere, and thus causes climate change. However, one of the problems with these studies is that they consider the relationship between tourism and air pollution as a one-sided relationship running from tourism to air pollution, and either simply assume or refer to secondary evidence that tourism development and air pollution may in reality have a bidirectional causal relationship.

With regard to the empirical studies, it is of note that the impact of tourism on air pollution has been extensively researched for various regions and/or countries, while the impact of air pollution on tourism has been examined less extensively.

For instance, Al-Mulali et al. (2015) assessed the impact of tourist arrivals on CO_2 emissions from the transportation sector in 48 top international tourism destinations and found that tourist arrivals have a significantly positive impact on CO_2 emissions released from transportation in all regions except Europe. Similarly, Zaman et al. (2016), in a panel study of 34 developed and developing countries, confirmed the negative environmental impact associated with increase in tourism. Their finding is consistent with that of Leon et al. (2014), who examined the tourism-air pollution nexus in a panel of developed and developing countries and found a substantial positive impact of tourism on CO_2 emissions for both panels. However, the impact is more significant for the developed countries.

There have been some contradictory findings suggesting that the development of tourism may enhance environmental quality (reduce air pollution). For example, Rasekhi et al. (2016) used the panel data method to examine the environmental impacts of tourism in 55 developing and developed countries and found that the impact of tourism on environmental quality is positive for developed countries, while the effect is negative in developing countries. In contrast, Lee and Brahmasrene (2013) investigated the impact of tourism expansion on CO_2 emission and economic growth in a panel of 27 European Union (EU) countries and found that expansion of tourism in the EU reduces per capita CO_2 emissions.

One shortcoming of these studies is the failure to explicitly account for cross-sectional dependency and heterogeneity that may exist in the series. As discussed earlier, inability to account for cross-sectional dependence and heterogeneity in panel data analysis can lead to spurious results and unreliable deductions and policy prescriptions. Consequently, Paramati et al. (2017), in a comparative study of 28 European Union (EU) countries, utilized a panel data analysis framework that explicitly accounts for cross-sectional dependency and heterogeneity across the countries and found that tourism growth had an adverse impact on the environment in Eastern Europe, while economic growth and CO_2 emissions stimulate tourism in Western Europe .

Following the same methods used by Paramati et. al (2017), Dogan et al. (2017) investigated the impacts of energy consumption, real GDP, tourism and trade on CO_2 emissions in OECD countries during the period 1995-2016. The results of the analysis show that tourism developments have an increasing effect on carbon emissions. Similarly, Kocak et al. (2020) examined the impact of tourism developments on CO_2 emissions in the most visited countries of the globe for the period 1995-2014 using a panel data analysis method which takes into account cross-sectional dependence. The results of the analysis show that tourism arrivals increase CO_2 emissions, while tourism receipts have a reducing effect on carbon emissions.

In addition to the aforementioned regional panel studies, examples of country specific studies include: Katircioglu (2014), who investigated the effects of tourism growth on environment pollution in Turkey and found that the former is positively correlated with energy use, which also adversely affects the climate of the country; Raza et al. (2017), who using the wavelet transform framework confirmed that tourism adversely affects the environment in the United States; Amzath and Zhao (2014), who examined the relationship between carbon emission and tourism development in the Maldives and found a significantly positive correlation between tourism development indicators and carbon emission; and Sharif et al. (2017) who found a positive long-run relationship between tourist arrivals and CO_2 emissions for Pakistan and unidirectional causality running from tourist arrivals to CO_2 emissions. Their finding is like that of Solarin (2014), who used cointegration and causality tests to examine the relationship among tourist arrivals and macroeconomic determinants of CO_2 emissions in Malaysia, and found unidirectional causality running from tourism to environmental pollution in the long run.

In their study, Ahmad et al. (2019) explored the nexus between tourism development and environmental quality for Vietnam, Indonesia and the Philippines and found a negative impact of tourism on environmental quality for Indonesia and the Philippines, while for Vietnam the opposite was the case with tourism improving environment quality. The authors took these findings to be an indication that the effect of tourism on the environment can differ among countries within the same region. Ahmad et al. (2018) further indicated that the impact of tourism on the environment varies across different provinces. In their work on the five western provinces of China, the authors found that tourism development has a negative effect on the environment in Ningxia, Gansu, Sanxi and Qinghai, whereas it enhances the environmental quality in Xinjiang. Likewise, investigating the link between tourism development and environment pollution, Zhang and Gao (2016) found significant differences among various regions of China. Meanwhile, Jebli et al. (2015) examined the causal relationship between real income, CO_2 emissions, and tourism in Tunisia and found that tourism increases CO_2 emissions; moreover, there exists a bidirectional causality between tourism and CO_2 emissions in the long run. This result mirrors the finding of Zaman et al. (2011) of a bidirectional causal relationship between tourism and carbon emission in Pakistan.

There is another cluster of studies which has implicitly hinted at the possibility that a bidirectional causal relationship exists between tourism development and environmental degradation. These studies show that while environmental pollution influences tourism, there are multiple segments of the tourism industry (transportation, accommodation, food services and other tourist activities) which could also have impacts on the environment (Holden, 2007; Brida and Pereyra, 2009;

Sompholkrang 2014; Fernandez et al., 2019). More recently, a number of scholars have provided empirical evidence of the double causality between tourism and environmental pollution. Ouattra and Perez-Barahona (2019), using a panel-based error-correction model, confirmed bidirectional causality running between tourist arrivals and environmental degradation for a sample of 22 Caribbean countries. Azam et al. (2018) found mixed evidence regarding impact of tourism on air pollution in Malaysia, Thailand and Singapore; the impact is positive for Malaysia but negative for the other two Southeast Asian economies. Similarly, the study by Tugcu and Topcu (2018) for a panel of ten major tourist destinations showed mixed evidence of the impact of various emissions on tourism receipts.

Overall, most of the previous studies arrived at the conclusion that, in one way or another, tourism development had an impact on environmental pollution. In addition, there is both implicit and explicit evidence that environmental pollution could impact tourism development. The lack of consensus reached by extant studies may be attributed to the differing time period examined for different countries and/or for the same country and region. It may also be attributed to variable selection, the availability, or lack of availability, of data for a specific variable or country, and statistical or econometric techniques used. Such wide–ranging results make it difficult for researchers and policymakers to generalize these results beyond the specific study area.

Methodology and Data

Empirical Methodology

Consider the standard panel data model:

$$y_{it} = \alpha_i + \varphi_i t + \beta_i^{'} X_{it} + u_{it} \tag{1}$$

where $i = 1, 2, ..., N$ represents the cross-section dimension, $t = 1, 2, ..., T$ refers to the time period, X_{it} is a (K x 1) vector of explanatory variables. Parameters α_i and $\varphi_i t$ allow for country specific fixed effects and deterministic trends. β_i represents the slope coefficients which are allowed to vary across countries, and u_{it} represents the estimated residual which indicate deviations from the long-run relationship.

The choice of a statistically appropriate method for the analysis of causality for panel data requires the assessment of cross-sectional dependence, because a shock that occurs in one of the Caribbean states may affect other countries even though they differ in their socio-economic background, environmental pollution and level of international visitor arrivals. Therefore, before considering causality, we investigated the characteristics of the panel data.

The second important issue before carrying out causality tests is to find out whether the slope coefficients are treated as homogenous or heterogeneous to impose causality restrictions on the estimated parameters. If the slope homogeneity is assumed without any empirical evidences, differences of the countries included in the analysis are ignored and the estimations become inconsistent (Breitung, 2000). Moreover, Granger (2003) points out that the causality from one variable to another variable by imposing the joint restriction for whole panel is a strong null hypothesis.

Accordingly, before we conduct tests for causality, we start with testing for cross-sectional dependence, followed by slope homogeneity across countries. Then, we decide which panel causality method would be most suitable for detecting the direction of causality between tourism development and air pollution in the Caribbean. The essentials of the econometric methods employed in this study are outlined below.

Testing Cross-Sectional Dependence

We test for cross-sectional dependence using the Lagrange Multiplier (LM) test of Breusch and Pagan (1980); the Cross Dependence Lagrange Multiplier (CD_{LM}) and Cross-sectional Dependence (CD) tests of Pesaran (2004); and the bias-adjusted LM (LM_{adj}) test of Pesaran et al. (2008). For each of these tests, the null hypothesis states that “there is no cross-dependence among countries”, while the alternative hypothesis states otherwise.

Testing Slope Homogeneity

The second issue before carrying out panel causality tests is to find out whether the slope coefficients are treated as homogenous or heterogeneous. The most common approach to testing the null hypothesis of slope homogeneity ($H_0 : \beta_i = \beta_j$ for all i-against the hypothesis of heterogeneity- $H_1 : \beta_i \neq \beta_j$ for a non-zero fraction of pair-wise slopes for $i \neq j$) is to apply the $\hat{S}$ statistics developed by Swamy (1970). Swamy’s (1970) test, however, is not applicable for all panel models data because of size restrictions. Pesaran and Yamagata (2008) improved the Swamy test and implemented the delta $(\hat{\Delta})$ homogeneity test, which is valid for large samples, and delta-adj $(\hat{\Delta}_{adj})$ homogeneity test valid for small samples.

Bootstrap Panel Granger Causality Analysis

The existence of both cross-sectional dependence and heterogeneity across country groups requires a method of analysis which would be able to accommodate both these dynamics. Konya (2006) proposed a panel Granger causality method which is based on Seemingly Unrelated Regressions (SUR) and Wald tests with county-specific bootstrap critical values. The method takes into account the characteristics of cross-section dependence and heterogeneity across countries, and does not require pretesting for panel unit-roots and cointegration; though it still requires the specification of the lag structure. Given its superiority[3], we will implement this approach in this paper.

Konya's (2006) panel causality approach by can be studied using a system which includes two sets of equations. This system can be formulated as follows:

$$\begin{cases} TA_{1,t} = \alpha_{1,1} + \sum_{i=1}^{lTA_1} \beta_{1,1,i} TA_{1,t-i} + \sum_{i=1}^{lEQ_1} \partial_{1,1,i} EQ_{1,t-i} + \varepsilon_{1,1,t} \\ TA_{2,t} = \alpha_{1,2} + \sum_{i=1}^{lTA_1} \beta_{1,2,i} TA_{2,t-i} + \sum_{i=1}^{lEQ_1} \partial_{1,2,i} EQ_{2,t-i} + \varepsilon_{1,2,t} \\ \vdots \\ TA_{N,t} = \alpha_{1,N} + \sum_{i=1}^{lTA_1} \beta_{1,N,i} TA_{N,t-i} + \sum_{i=1}^{lEQ_1} \partial_{1,N,i} EQ_{N,t-i} + \varepsilon_{1,N,t} \end{cases} \quad (2)$$

and

$$\begin{cases} EQ_{1,t} = \alpha_{2,1} + \sum_{i=1}^{lTA_2} \beta_{2,1,i} TA_{1,t-i} + \sum_{i=1}^{lEQ_2} \partial_{2,1,i} EQ_{1,t-i} + \varepsilon_{2,1,t} \\ EQ_{2,t} = \alpha_{2,2} + \sum_{i=1}^{lTA_2} \beta_{2,2,i} TA_{2,t-i} + \sum_{i=1}^{lEQ_2} \partial_{2,2,i} EQ_{2,t-i} + \varepsilon_{2,2,t} \\ \vdots \\ EQ_{N,t} = \alpha_{2,N} + \sum_{i=1}^{lTA_2} \beta_{2,N,i} TA_{N,t-i} + \sum_{i=1}^{lEQ_2} \partial_{2,N,i} EQ_{N,t-i} + \varepsilon_{2,N,t} \end{cases} \quad (3)$$

where TA_{it} denotes tourism development; EQ_{it} denotes air pollution; α represents constant terms and β and ∂ are coefficients; N denotes the number of countries in the panel (i=1,2,..,N); t is t time period(t=1,…,T); and $lTA_{1i}, lEQ_{1i}, lTA_{2i}$, and lEQ_{2i} indicate the lag lengths. The error terms $\varepsilon_{1,i,t}$ and $\varepsilon_{2,i,t}$ are supposed to be white-noises and may be correlated with each other for a given country, but not across countries.

The system (Equations 2 and 3) is estimated by the (SUR) seemingly unrelated regressions procedure, since possible links may exist among individual regressions via contemporaneous correlation within the system of equations. Wald tests for Granger causality are performed with country specific bootstrap critical values generated by

3 There are several advantages of Konya's (2006) proposal. First, in this approach, the panel is assumed heterogeneous. Therefore, the Granger causality test can be performed for each country separately and as such allows the determination of how many and for which countries in the panel there exists one-way Granger-causality, two-way Granger-causality, or no Granger-causality. Second, because contemporaneous correlation is allowed across countries, it is possible to leverage the extra information provided by the panel data and generate country-specific bootstrap critical values. Third, the procedure does not require pretesting for panel unit-roots or cointegration; therefore, the pretest biases and size distortion problems are avoided. This is an important feature since it has been widely acknowledged that standard unit root and cointegration tests can have low power against stationary alternatives, and different tests often lead to contradictory outcomes.

simulations[4]. In this framework, for country *i:* (1) unidirectional Granger causality would run from EQ to TA if not all $\partial_{1,j,i}s$ are zero, but all $\beta_{2,j,i}s$ are zero; (2) unidirectional Granger causality would run from TA to EQ if all $\partial_{1,j,i}s$ are zero, but not all $\beta_{2,j,i}s$ are zero; (3) two-way Granger causality would exist between EQ and TA if neither $\partial_{1,j,i}s$ nor $\beta_{2,j,i}s$ are zero; and (4) no causality would exist between TA and EQ if all $\partial_{1,j,i}s$ and $\beta_{2,j,i}s$ are zero.

Since results from the causality test may be sensitive to the lag structure, determining optimal lag length(s) before proceeding with the estimation is crucial for robustness of findings. Following Konya (2006), we allow the optimal lag length to be the same across equations but to vary across variables. Assuming that the number of lags ranges from 1 to 4, we estimated all equations and used the Akaike Information Criterion (AIC) and Schwartz Criterion (SC) to determine the optimal lag structure.

Data

The analysis of causal relationship between tourism development and air pollution based on annual panel data was carried out over the period 1995-2017 for twelve Caribbean countries: Antigua and Barbuda, The Bahamas, Barbados, Cuba, the Dominican Republic, Guyana, Haiti, Jamaica, St. Kitts and Nevis, St. Lucia, Trinidad and Tobago, and British Virgin Islands. The choice of the period and of the countries for the analysis was governed by data availability to ensure a balanced panel structure.

In the literature, there are essentially two measures of tourism developments: tourism receipts or expenditures and tourist arrivals and overnight stays (Gricar and Bojnec, 2019). The World Tourism Organization (UNWTO) also focuses on these two indicators to measure tourism developments. An inherent problem with using tourism receipts or expenditures as a measure of tourism developments is the lack of reliable data on tourist receipts/expenditures. In addition, the data on tourism receipts/expenditures may not be reliable because they are generated from bank records of foreign exchange transactions, and/or sporadic survey of tourists and tourism establishments. These data generating processes are prone to sampling, non-response, and measurement errors. In contrast, data on tourist arrivals are well documented through the compulsory completion of disembarkation cards. Given these facts, in order to avoid erroneous inferences, we represent tourism developments (TA) through international tourist arrivals (international visitors that stay overnight) because such data are available with long, consistent series for the Caribbean countries under study.

As we discussed earlier, the use of energy in tourism-related activities (transportation, accommodation, facilities, shopping activities and attractions) leads

4 For details and explanation of the estimation and testing procedures, see Konya (2006) and Tekin (2012).

to a significant amount of greenhouse gases emissions into the environment, mainly carbon dioxide (CO_2) (Lenzen et al., 2018). Consequently, following the literature, CO2 emissions (per capita in metric tons) are used as a proxy variable for air pollution **(EQ)**. The CO_2 includes carbon emissions stemming from the burning of fossil fuels and the manufacture of cement. They also include carbon emissions produced during consumption of solid, liquid and gas fuels and gas flaring.

Data on international tourist arrivals are from the World Tourism Organization (UNWTO, 2018) and the Caribbean Tourism Organization (CTO) website at www.onecaribbean.org. Data on CO_2 emissions come from the World Development Indicators database of the World Bank (2017). However, the World Bank contains data for CO_2 emissions only until 2013. Therefore, this variable has been supplemented by data from the EDGAR- Emissions Database for Global Atmospheric Research website: https://edgar.jrc.ec.europa.eu/overview.php?v=booklet2019 for the years 2014-2017.

Empirical Results

Cross-sectional dependence and Slope homogeneity

As outlined earlier, before implementing the Granger causality procedure, we conducted cross-sectional dependence and slope homogeneity tests. Table 1 shows the results of these tests. According to the statistics of the LM_{BP}, CD_{LM}, CD and LMadj tests, there is cross-section dependence among the countries at the 1% significance level. This means that any tourism or air pollution shock in one of the Caribbean countries affects the other countries too.

Table 1
Cross-sectional Dependence and Slope Homogeneity Tests.

	Cross-sectional Dependency tests				Slope Homogeneity tests	
Variables	LM_{BP}	CD_{LM}	CD	LM_{adj}	$\hat{\Delta}$	$\hat{\Delta}_{adj}$
TA	406.584***	29.644***	3.289***	29.371***	12.865***	17.292***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
EQ	470.398***	35.198***	7.467***	34.925***	13.871***	19.425***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Note: The probability values are in parentheses. *** indicates significance at the 1% level.

The statistics of the $\hat{\Delta}$ and $\hat{\Delta}_{adj}$ tests show that there is heterogeneity at a 1% significance level. This suggests that each of these countries retains their own unique characteristics, therefore the direction of causality between tourism development and environmental quality may differ across the twelve countries.

Causality

Both the cross-sectional dependence and the slope heterogeneity tests provide evidence for the suitability of the Konya (2006) bootstrap panel Granger causality approach for examining the relationship between tourism development and air pollution in the Caribbean countries.

Table 2 shows the Granger causality relationships between tourism development and air pollution. The TSP routine written by Laszlo Konya was used to obtain these causality results. We are grateful to Laszlo Konya for sharing his codes.

Table 2

Results of Konya Bootstrap Panel Granger Causality Test

Countries	Ho: TA does not Granger cause EQ (H_1: TA causes EQ)					Ho: EQ does not Granger cause TA (H_1: EQ causes TA)				
	Coefficient	Wald Statistic	Bootstrap critical value			Coefficient	Wald Statistic	Bootstrap critical value		
			10%	5%	1%			10%	5%	1%
Antigua & Barbuda	0.035	12.915*	10.761	15.835	32.879	-0.029	3.865	9.873	14.264	29.873
The Bahamas	0.077	7.917	10.715	15.900	33.672	-0.085	12.001*	10.002	15.332	33.977
Barbados	0.081	24.267**	9.084	15.686	29.053	-0.062	17..004**	10.101	16.708	3 1.233
Cuba	0.072	15..667**	10.908	15.319	34.590	-0.058	4.003	10.077	16.118	31.267
Dominican Republic	0.114	14.514*	10.640	16.751	34.339	-0.078	11.410*	10.483	16.552	32.213
Guyana	0.101	14.011**	8.086	11.302	24.979	-0.049	3.002	9.837	11.677	25.295
Haiti	0.102	2.966	8.187	11.702	28.835	-0.044	11.967**	7.805	11.895	27.114
Jamaica	0.102	31.277**	15.887	23.977	47.529	-0.068	19.809*	16.010	24.969	45.295
St. Kitts & Nevis	0.052	3.928	8.856	13.331	24.626	0.049	4.745	9.414	16.839	28.127
St. Lucia	0.206	17.944*	13.744	20.957	39.197	-0.121	18.401**	10.942	17.450	36.196
Trinidad & Tobago	0.342	59.732***	9.728	15.266	38.378	-0.176	27..636**	12.716	22.654	41.971
British Virgin Island	0.198	13.622*	9.715	15.977	29.115	-0.040	3.399	12.044	16.076	37.720

Note: ***, **, and * indicate significance at 1, 5, and 10% significance levels, respectively. Bootstrap critical values are based on 10,000 replications.

According to Table 2, there is a bidirectional Granger-causality between **TA** and **EQ** in Barbados, Dominican Republic, Jamaica, St. Lucia, and Trinidad and Tobago; a one-way Granger causality running from **TA** to **EQ** in Antigua and Barbuda, British Virgin Islands, Cuba, and Guyana; a reverse relationship running from **EQ** to **TA** was found for The Bahamas and Haiti. For St. Kitts and Nevis, no causal relationship running between **TA** and **EQ** was found to exist.

The presence of Granger causality between **TA** and **EQ** should not be interpreted off-hand as **EQ** contributes positively to **TA**, and vice versa (Konya 2006, p. 991). Hence, determining the signs of the regression coefficients involved in the causality tests is also critical since the null hypothesis [Ho: **EQ** does not Granger cause **TA**] implies positive effects where increases in **EQ** lead to increases in **TA**, and [Ho: **TA** does not Granger cause **EQ**] increases in **TA** lead to increases in **EQ**. Hence, in Equation (2) the sign on the $\partial_{1,i,i}$ parameters is expected to be negative (i=1, 2..., N), and in Equation (3) the sign on $\beta_{2,j,i}$ is expected to be positive. As can be seen from Table 2, the coefficient of the **EQ** variable is negative for all countries with the exception of St. Kitts and Nevis suggesting that for all the countries except St. Kitts/ Nevis, increased environmental degradation (carbon emissions) negatively affects tourism[5]. The coefficient on the TA variable is positive for all the countries suggesting that increased tourist arrivals increase the level air pollution (CO2 emissions) in these countries.

Policy Implications

The interrelationships between tourism development, the underlying economy and the natural environment have been important interest areas for researchers during the last two decades. In this context, this study examines the causal nexus of tourism development and air pollution (environmental quality) in a panel of twelve Caribbean SIDs in the period 1995-2017 using Konya's (2006) bootstrap panel Granger causality test technique which accounts for dependency and heterogeneity across countries. The results of the causality analysis show that the existence and direction of Granger causality differ among the different countries under study. In order to have a clear picture, the different causality results for TA and EQ are shown in Table 3. Each of these results has important policy implications and recommendations.

Table 3
Summary for the directions of causality between TA and EQ

Country	$TA \leftrightarrows EQ$	$TA \rightarrow EQ$	$EQ \rightarrow TA$	$TA \neq EQ$
Antigua and Barbuda		X		
The Bahamas			X	
Barbados	X			
Cuba		X		
Dominican Republic	X			
Guyana		X		
Haiti			X	
Jamaica	X			
St. Kitts and Nevis				X
St. Lucia	X			
Trinidad and Tobago	X			
British Virgin Island		X		

For Barbados, Dominican Republic, Jamaica, St. Lucia, and Trinidad and Tobago, a bidirectional Granger causality was found to exist between **TA** and **EQ**. This suggests that tourism development and air pollution have predictive power over one

5 The sign of the causal effect is derived from the sum of the coefficients of the variable considered as independent in a specific equation. So, in our case, the sign is based on the sum of the coefficients of the maximum number of lags of the causal variable.

another in this group of five countries. Specifically, the enhancement of tourism appears to play a role in the environmental pollution of these countries, and vice versa. From a policy standpoint, policies directed at tourism enhancement in these countries increase CO_2 emissions which may, in turn, hamper tourism. Alternatively, policies that focus on utilizing resources efficiently and on improving the environment quality would also enhance tourism. This result underscores the importance of balancing tourism and environmental conservation policies in the tourism-dependent and environmentally sensitive tourist destinations. These findings of bidirectional causality relationship between tourism and CO_2 emissions are similar to the studies by Akadiri et al. (2018) for 16 small island developing countries, Ouattra and Perez-Barahona (2019) for selected Caribbean countries, and Kocak et al. (2020) for the most visited countries across the globe.

In the case of Antigua and Barbuda, British Virgin Islands, Cuba, and Guyana, we found one-way Granger causality running from **TA** to **EQ** with no feedback. This means that increases or decreases in international tourist arrivals have a major influence on the environmental quality, particularly in this group of three countries. The unidirectional causality may also imply that the level of per capita CO_2 emissions is not enough to deter tourists from coming to these countries. These findings are consistent with those of Katircioglu (2014) for Turkey, Solarin (2014) for Malaysia, and Paramati et al. (2016) for Western EU countries.

Regarding The Bahamas and Haiti, we found unidirectional causality running from **EQ** to **TA**, with no feedback. This means that developments in the tourism sector are influenced by environmental quality but the increase in tourist arrivals does not necessarily increase environmental degradation. This finding is similar to Bubb's (2017) who concludes "that while the natural environment may be an important factor in attracting tourists, there are other sources of environmental degradation that may be more significant than those caused by tourists. One of these may be degradation caused by natural disasters like hurricanes, storm surges and rising global temperatures, all of which are related to climate change."

The policy implication is that environmental conservation policies adopted by the policymakers may be feasible without compromising the number of tourists visiting these countries and hence, their economic growth. The local government and other tourism industry stakeholders therefore need to be very deliberate about using resources efficiently to improve the quality of the environment, because the positive effects of improved environmental quality will transmit to the tourism product. The UNWTO estimates that the transportation and accommodation sectors in tourism contribute 75% and 21% respectively to all tourism emissions. To alleviate environmental pollution throughout the tourism value chain, the local government and tourism industry stakeholders could adopt a green tourism agenda that discourages consumption of fossil fuels, promotes socially aware and environmentally responsible practices in service and management, and encourages tourists to behave in environmentally friendly ways.

In St. Kitts and Nevis, no evidence of Granger causality running in any direction between **TA** and **EQ** was found to exist. This suggests that the two variables are independent of one another. Since there is no causal relationship between **TA** and **EQ**, increases in tourist arrivals may not affect environmental quality and environmental quality does not affect tourism development. The lack of a causal relationship between **TA** and **EQ** may reflect the fact that while there are steadily increasing levels of CO_2 emissions with tourist arrivals in St. Kitts and Nevi, the levels of emissions are still relatively low in per capita terms to have a significant impact on the tourism industry. However, while St. Kitts and Nevis does not seem to need to reduce tourism activities in order to improve environmental quality, or improve environmental quality in order to enhance tourism, lack of well-planned and executed environmentally-sensitive sustainable tourism policies could prove detrimental to the industry in the long-run.

Conclusion

In this paper we have studied the possibility of Granger causality between tourism and environmental quality in twelve Caribbean SIDs over the period 1995-2017 in a panel-based model that both allows for the assessment of causality in countries with cross-sectional dependency and heterogeneity, and avoids the problem of incorrect specification associated with conventional panel unit root and cointegration tests. Applying this model, we found strong evidence of dependency and heterogeneity across the countries, implying that each country sustains its environmental conservation and tourism policies, each Caribbean country is a special case, thus, an overall "umbrella" policy recommendation would not be appropriate.

The future of Caribbean tourism is inextricably linked to the quality of the natural environment, and the economic viability and competitiveness of the Caribbean tourism industry can only be sustained if the quality of these resources is maintained (Dixon et al., 2001). Consequently, the tourism industry stakeholders and policymakers in charge of environmental policies should make a concerted effort to harmonize tourism policies with national environmental conservation policies in the transition towards a sustainable tourism sector. This would maximize the potential of the tourism industry in creating green jobs that would contribute to preserving and enhancing the environment and maximizing economic growth and competitiveness.

Future researchers could focus on investigating the relationship between tourism and environmental pollution for other SIDs in the Caribbean region, and elsewhere around the world, as the data becomes available. These studies could be particularly useful in keeping track of the varying impacts of environmental policies of any given country on the tourism industry. Furthermore, given heightened concerns about global environmental changes and about tourism and the carbon-footprint of global tourism, an active and ongoing research is crucial not only for furthering green tourism in the environmental hotspots, but also for striking the right balance between tourism development, environmental sustainability and economic sustainability.

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