The Impact of Climate Change on Caribbean Tourism Demand

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Abstract

Climate change can either positively or negatively impact on the attractiveness of a destination. To evaluate the potential effects of these changes for Caribbean destinations, a cross-country tourism demand model is augmented with relative tourism climatic indices to examine the importance of an island's climatic features. The model is estimated using the panel ARDL approach and monthly observations over the period 1977 to 2006. Combining the scenarios for future climatic conditions as well as the coefficient estimates obtained, anticipated scenarios of the direct effects of climate change on tourist arrivals to the region are provided. In addition, merging this data with estimates of average visitor expenditure gives a dollar estimate of the impact on the tourism industry and the overall economy.

JEL Classification: C23; Q5; L83

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1. Introduction

Individuals consume tourism services in order to obtain some pleasure or satisfaction. The nature of tourism therefore implies that the demand for this service will be intimately related to the satisfaction it provides. One factor that can potentially impact on perceived satisfaction is climate. Climate's impact on tourism can be physical, physiological and psychological (Table 1). For example, increased rain or high wind implies that the visitor may have to delay or not have the chance to visit some particular attraction or pursue some activity of interest. Other factors falling into this category might be ice, snow, severe weather, air quality and ultraviolet radiation. In terms of the physiological and psychological aspects of visitor satisfaction, factors such as high air temperature and blue skies may affect environmental stress, hyperthermia and general enjoyment or attractiveness of the destination.

Table 1: Climate and the Potential Impact on Tourism

Facet of Climate	Significance	Impact
Aesthetic		
Sunshine/cloudiness	Quality of experience	Enjoyment, attractiveness of site
Visibility	Quality of experience	Enjoyment, attractiveness of site
Day length	Convenience	Hours of daylight available
Physical		
Wind	Annoyance	Blown belongings, sand, dust…
Rain	Annoyance, charm	Wetting, reduced visibility and enjoyment
Snow	Winter sports/activities	Participation in sports/activities
Ice	Danger	Personal injury, damage to property

Severe weather	Annoyance, danger	All of the above
Air quality	Annoyance, danger	Health, physical wellbeing, allergies
Ultraviolet radiation	Danger, attraction	Health, suntan, sunburn
Thermal		
Integrated effects of air temperature, wind, solar radiation, humidity, long wave radiation, metabolic rate	Thermal comfort, therapeutic, restorative	

Source: de Freitas (2003)

Although the climatic features of a destination may impact on visitor satisfaction, it is unclear whether or not these individuals pay attention to this factor when planning their trip. Hamilton and Lau (2004) therefore examine this issue through the use of a self-administered questionnaire distributed at the airport, international bus stations and train stations in Germany. The results of the questionnaire suggest that the majority (73 percent) of visitors tend to inform themselves in relation to the climate of a destination, with 42 percent doing so before they make their travel arrangements. Uyarra et al. (2005) undertook a similar analysis for visitors to the islands of Bonaire and Barbados. Based on a survey of 338 individuals, the study found that warm temperatures, clear waters and low health risks were the main environmental features important to visitors to these islands. Visitors to Bonaire, however, placed more emphasis on marine wildlife attributes while those to Barbados reported that beach characteristics were more important. To evaluate the impact of climate Uyarra et al. solicited responses in relation to re-visit probability in the event of coral bleaching and sea level rise. In this regard, the study found that 80 percent of tourist reported that they would not return to the island in the event of these occurrences.

Although there are a number of articles in the area of modelling tourism demand, the literature on the potential impact of climate change on tourism demand in the Caribbean is scarce. This study augments a standard model of tourism demand with an index of climatic features developed by Lewis-Bynoe et al. (2009) for the Caribbean. The predictive ability of the model is then evaluated and employed to forecast the potential impact of changes in climatic features on regional tourism demand. The paper adds to the literature in three main areas. First, it provides estimates of the importance of climatic features to historical tourism demand in the Caribbean. Second, and in contrast to much of the literature, which ignores home country effects (i.e. whether or not visitors might substitute away from international tourism altogether and instead consume more domestic tourism services), explicit account is taken of potential home country effects. Third and finally, projections of the likely implications of climate change under various scenarios are provided.

The remainder of the study is structured as follows. Section 2 gives a review of related literature, while Section 3 proposes an approach to modelling and forecasting the potential impact of climate change on tourism demand. Section 4 presents the estimated model as well as projections for tourism demand under various climate change scenarios. Section 5 summaries the main findings of the study and also provides some key policy recommendations emanating from the study.

2. Literature Review

Most of the early approaches to assessing the impact of climate change on tourism focussed on a single variable: temperature. One of the earliest studies in the area, Abegg and Koenig (1997), evaluated the impact of predicted changes in weather conditions on the winter tourism industry in Switzerland. Abegg and Koenig (1997) reported that, under current climate conditions, 85% of all Swiss ski areas are snow-reliable. However, this number would drop to 63% if temperatures were to rise by 2ºC and therefore have implications for regionally balanced economic growth.

Since this initial study, there have been numerous studies employing a similar approach (see Scott, 2003, for a survey of this literature). This body of literature suggests that climate change is likely to have two main effects: (1) the length of the tourist season, and; (2) the natural environment. In some instances climate change resulted in an improvement in the length and quality of the tourist season while in others it had negative implications. Lise and Tol (2002), also using temperature as their main measure of the effects of climate change, use regression techniques to find the optimal or preferred temperatures of visitors emanating from the Organisation for Economic Cooperation and Development (OECD) group of countries. The authors report that visitors from these countries tend to prefer a temperature of around 21ºC at their choice of holiday destination. Lise and Tol therefore suggest that global warming could therefore in a shift away from some destinations that either become too hot or too cold.

One of the drawbacks of the approaches suggested above is that they focus on just one particular characteristic of a destination's weather (temperature) to make predictions of likely impact of climate change. Mieczkowski (1985), however, conceptualised that tourist destinations are usually characterised by climatic conditions that would be most comfortable for the average visitor. The author therefore developed a tourism climate index (TCI) that was a weighted average of seven (7) climatic variables: (1) monthly means for maximum daily temperature; (2) mean daily temperature; (3) minimum daily relative humidity; (4) mean daily relative humidity; (5) total precipitation; (6) total hours of sunshine, and; (7) average wind speed.[2] The calculated TCI ranged from -20 (impossible) to 100 (ideal).

Scott and McBoyle (2001) also use the TCI to evaluate the potential impact that climate change can have on the tourist industry in 17 US cities. The authors calculated historical as well as projected TCIs for two scenarios: CGCM2 and HadCM2 for the 2050s and 2080s. The results suggested that western Canadian cities (Calgary, Vancouver and Yellowknife) would experience some improvement in tourism features, while those in eastern Canada (Toronto and Montreal) should experience some deterioration. Similar approaches were employed by Harrison et al. (1999) in relation to the ski industry in Scotland, while Amelung et al. (2007) use the simulated TCI approach to investigate the shifts that are likely to occur in tourist flows as a result of climate change in a sample of tourist destinations.

While simulating the TCI under various climate change scenarios provides important information on the relative attractiveness of a destination in the future, it cannot provide estimates of the impact these changes are likely to have on tourism demand. As a result, some authors have used the generated TCI in a model of tourism demand to project the potential impact of these

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[2] Each variable was standardized to take values ranging from 5 for optimal to -3 for extremely unfavourable before the index was calculated.

forecasted changes on tourism features. Hein (2007), for example, augments a model of tourism demand in Spain with the TCI index for this country to identify the potential impact that changes in climatic conditions can have on the future of the industry there. The author finds that tourist flows to this destination could fall by up to 20 percent by 2080 compared to 2004, largely due to higher temperatures during the summer. However, during the spring and autumn, there could be increased visitor arrivals.

One of the limitations of TCI approach is that it assumes there is some ideal climatic condition across destinations. Scott et al. (2007), however, argues that this might not necessarily be the case. The study examines tourists' perceptions of the ideal climatic conditions in relation to four variables (air temperature, precipitation, sunshine and wind) and in three regions (beach-coastal, urban and mountains). The study utilised responses to structured questionnaires from a sample of 831 university students from Canada, New Zealand and Sweden. The results suggested that the ideal climatic conditions tended to vary in the three tourism environments. Moreover, the relative importance of the ideal climatic parameters was not the same across nations. While these results may suggest that the TCI may lead to some misleading preferences across countries, it was limited by focusing on a very small segment of the market, i.e. young tourist.

Lin and Matzarakis (2008), acknowledging that visitors from particular countries might respond in different ways to changes in temperature, develop physiologically equivalent temperatures for tourist visiting five national parks on the main island of Taiwan based on their region. The authors find that this approach generated better predictions of tourist flows relative to the traditional approaches that do not take visitor backgrounds into account.

Rather than focusing on the climatic features of the home destination, Berrittella et al. (2006) attempt to consider the effects of climate change on the general consumption preferences of tourists using a world computable general equilibrium model to assess the potential effects of climate change. The impact of climate change on tourism is captured through two channels: changes in the structure of final consumption (private domestic purchases to be specific) and international income transfers, since spending by visitors in the domestic economy impacts on consumption as well as income transfers. Berrittella et al. (2006) project that net losers are likely to be Western Europe, energy exporting countries and the rest of the world, which contains the Caribbean, and are forecasted to be become too hot to be pleasant. Hamilton et al. (2005) also obtain similar projections by using a model of global tourism flows to project the potential impact of higher temperatures on tourist flows.

3. Empirical Approach

The TCI offers a useful way to summaries the potential implications that climate change could have on the attractiveness of a destination. It does not, however, present a quantitative assessment of the prospective impact on tourism demand. To obtain such an estimate, a standard demand model is augmented with the TCIs for each Caribbean island as well as that for its competitors. Following Kim and Uysal (1997), Lathiras and Siriopoulos (1998), Lee, Var and Blaine (1996), Lim (1997) as well as Song and Witt (2000) the tourism demand model is assumed to take the following form:

$$Arr_{it} = f(Y_{it}, P_t^B / P_{it}^S, P_t^B / P_t^C, F_{it}, EX_{it}) \qquad (2)$$

where Arr_{it} are total visitor arrivals from source market i in period t, Y_{it} is the income in the source market, P_t^B / P_{it}^S is the relative price of Barbados and the source market, P_t^B / P_t^C is the relative price in Barbados and its main competitor, F_{it} is the cost of travel between Barbados and the source market and EX_{it} is the bilateral exchange rates.

A priori, both income and the exchange rate should be positively associated with tourism demand since a rise in income in the source market should allow a larger number of people to afford to travel to the destination, while a depreciation (a rise in EX_{it}) would raise the purchasing power of individuals travelling to the destination. The two relative price variables and cost of travel should be negatively associated with tourism demand. A rise in air fares makes it more expensive to travel to the destination and should therefore reduce demand. Similarly, if prices in the destination are rising faster than those at home or in a competing destination, it would cost the individual relatively more to purchase goods and services if the individual makes the trip.

To account for the impact of climate features on tourism demand, Equation (2) is augmented with a relative TCI (relative to competitors):

$$Arr_{it} = f(Y_{it}, P_t^B / P_{it}^S, P_t^B / P_t^C, F_{it}, EX_{it}, TCI_t^B / TCI_t^C) \tag{3}$$

Some of the variables included in the specification are unlikely to be stationary, i.e. mean reverting. Ignoring the non-stationarity of the variables in the regression model can lead to invalid inferences (Pesaran and Smith, 1998). Therefore the autoregressive distributed lag (ARDL) framework (Pesaran and Shin, 1999; Pesaran et al., 2001) to estimating long run relationships between variables is employed. The approach to testing for the existence of a relationship between variables in levels is appropriate irrespective of whether the underlying regressors are I(0) or I(1). The long-run coefficient estimates obtained from the method are unbiased and efficient. In addition, the approach avoids issues related to omitted variables and serial correlation.

Consider the following general $ARDL(p,q)$ model:

$$\Delta y_t = \alpha_0 + \alpha_1 t + \phi y_{t-1} + \beta' x_{t-1} + \sum_{s=1}^{q-1} \beta^{*}{}' \Delta x_{t-s} + \sum_{s=1}^{q-1} \eta' \Delta y_{t-s} + u_t \tag{4}$$

where y_t are tourist arrivals, x_t is a $k \times 1$ vector of $I(1)$ explanatory variables that are not cointegrated and u_t is a residual terms that is assumed to possess normal properties (zero mean and constant variance-covariances). However, to obtain valid coefficient estimates, the ECM must exists (the adjustment parameter, ϕ must be negative and significant), the residuals must be uncorrelated and the explanatory variables must be strictly exogenous.

The study utilises annual data over the period 1980 to 2004 for 18 Caribbean islands. Observations on tourist arrivals are taken from the Caribbean Tourism Organisation's Annual Statistical Digest (various issues). The income of source countries, proxied by world GDP per capita, prices and the exchange rate are taken from the United Nation's National Accounts Database (online edition). Since observations on air fares are unavailable over the sample period, oil prices are employed as a proxy under the assumption that these two variables should be highly correlated.

Combining the scenarios for future climatic conditions as well as the coefficients from Equation (3), estimates of the direct effects of climate change on tourist arrivals to the Caribbean are provided. In addition, merging this data with estimates of average visitor expenditure, a dollar estimate of the impact on the tourism industry and the overall economy is obtained.

Data on various climate scenarios are taken from the Tyndall Centre for Climate Change Research. The database summarises projections from four models: (1) the Canadian Centre for Climate Modelling and Analysis Coupled Global Climate Model, CGCM2, (Flato and Boer, 2001); (2) Australia's Commonwealth Scientific and Industrial Research Organisation, CSIRO2, (CSIRO, 1996); (3) Parallel Climate Model, PCM, (Washington et al., 2000), and; (4) the UK’s Meteorological Office Hadley Centre Coupled Model (HADCM3). Four emissions scenarios (A1, A2, B2 and B1) outlined by the IPCC are also examined.

The emissions scenarios assume that the main driving forces of future greenhouse gas trajectories will continue to be demographic change, social and economic development, and the rate and direction of technological change. The A1 and B1 scenarios are based on the low International Institute for Applied Systems Analysis (IIASA) 1996 population projections: the world population is expected to rise to 8.7 billion by 2050 and fall toward 7 billion by 2100 due to a reduction in fertility as well as mortality. In contrast, the B2 scenario uses the long-term United Nation’s (UN) Medium 1998 population projection of 10.4 billion by 2100, while the A2 scenario assumes a high population growth of 15 billion by 2100 owing to a significant decline in mortality for most regions (see IPCC, 2000, for greater details). All scenarios exclude surprise or disaster scenarios and do not consider additional climate initiatives, such as the United Nations Framework Convention for Climate Change (UNFCCC) or the emissions targets of the Kyoto Protocol.

The four models and four emission scenarios provide 16 combinations of climate model and emission scenarios that cover 93 percent of the possible range of global climate change envisaged by the IPCC. Since each of the scenarios is just as likely the average of the 16 scenarios is employed. These forecasted climate indicators are used to calculate the anticipated change in the TCI for each of the 18 Caribbean countries under investigation.

4. Results

4.1 Evaluation of Empirical Tourism Demand Model

Before the model is estimated, tests for stationarity are undertaken for all the variables under consideration. This is done to ensure that the variables are not I(2), as the panel ARDL approach assumes that all the variables are either I(0) or I(1) and provides spurious results if this assumption is violated. Panel unit root tests for the variables included in the tourism demand model are provided in Table 2. The tests for unit roots are done using the Im, Pesaran and Shin (2003) W-stat. With the exception of relative TCI, all the other variables included in the Caribbean tourism demand model are nonstationary in levels, but stationary in first differences.

Table 2: Panel Nonstationarity Test Results

Variable	Log Levels		First Differences	
	AIC Lag	Im, Pesaran and Shin W-stat	AIC Lag	Im, Pesaran and Shin W-stat
Tourist Arrivals	4	1.329 [0.908]	2	-11.110 [0.000]
Income in Source Markets	0	4.064 [1.000]	0	-4.510 [0.000]
Prices Relative to	0	0.397	2	-5.312

Source Markets		[0.654]		[0.000]
Prices Relative to Competitors	1	-2.402 [0.010]	3	-7.696 [0.000]
Travel Costs	4	4.891 [1.000]	0	-18.195 [0.000]
Exchange Rate	1	2.361 [0.991]	2	-4.541 [0.000]
Relative TCI	1	-5.763 [0.000]	-	-

Once it has been identified that all the variables are at most I(1), the next step in the estimation process is to choose the appropriate model specification. In a panel data framework, the country-specific effects can be assumed to be constant (pooled) or vary across countries (fixed effects), specification tests are therefore employed to choose between these functional forms. To test the significance of the country specific effects a chi-square tests of the null hypothesis that the country effects can be suppressed was 490.432[0.000], suggesting that the null hypothesis cannot be accepted at normal levels of testing.

The results from employing the fixed effects model specification to estimate the error correction model are provided in Table 3. Two fixed effects specifications are examined: static fixed effects (long run coefficient estimates are obtained by estimating the tourism demand model in levels) and dynamic fixed effects (where the error correction model provided in Equation (4) are employed to obtain the long run coefficient estimates. Looking first at the static fixed effects model, the coefficient estimates were generally in agreement with *a priori* expectations: source market incomes and the exchange rate were both positively associated with tourist arrivals to the Caribbean, while prices relative to competitors and travel costs were inversely associated with the number of visitors to the region. The coefficient on the variable ‘prices relative to source’ was, however, positive. The positive coefficient on this relative price variable could simply be reflective of differences in the monetary policy targets in the Caribbean relative to source markets or the impact of tourist expenditure on domestic prices in the Caribbean.

Table 3: Model Estimation Results

	Static Fixed Effects	Dynamic Fixed Effects	
	Without TCI	Without TCI	With TCI
Income in Source Markets	0.940 (0.037)**	0.849 (0.048)**	0.758 (0.045)**
Prices Relative to Source Markets	0.606 (0.107)**	0.847 (0.080)**	0.903 (0.176)**
Prices Relative to Competitors	-0.440 (0.134)**	-0.770 (0.081)**	-0.990 (0.192)**
Travel Costs	-0.119 (0.033)**	-0.067 (0.036)*	-0.047 (0.042)
Exchange Rate	0.072 (0.025)**	0.069 (0.011)**	0.067 (0.015)**
Relative TCI	-	-	0.404 (0.219)*
Error Correction Term	-	-0.908 (0.018)**	-0.904 (0.034)**
R-squared	0.964	0.951	0.936
s.e. regression	1.032	0.230	0.201
Observations	450	360	306
Cross sections	18	18	18

The results from the dynamic fixed effects specification were broadly similar in terms of the directional and magnitudinal impact of the explanatory variables. The only real change was the size of the coefficient on the variable ‘pries relative to competitors’ which almost doubled in size. The error correction term, estimated at 0.908, suggests a relatively rapid speed of adjustment after a shock to tourist to regional arrivals: just over one year.

The final column of Table 3 provides the results from re-estimating the dynamic fixed effects tourism demand model augmented with the relative TCI variable. The coefficient estimates on the other explanatory variables are broadly similar to those obtained earlier. The positive and statistically significant coefficient estimate on the variable of interest, the relative TCI, indicates has two key implications: (1) climatic features have a statistically significant impact on tourism demand in the Caribbean, and; (2) a change in climatic features relative to competitors could lead to substitution away from a destination.

Given the importance of climatic features to regional tourism demand, it is important to assess the potential effects that climate change can have on future viability of the industry. One way to assess the impact of climate change on the regional tourist industry is to derive projections for the TCI under various climate change scenarios and utilise the tourism demand model to obtain possible scenarios for regional tourism. Before this is done, however, an assessment of the predictive ability of the tourism demand model is undertaken.

The tourism demand model is estimated using data from 1980 to 2000 and then employed to forecasting tourist arrivals over various horizons between 2001 and 2004. The forecasting performance is assessed relative to two naive models: (1) a model with only a constant, and; (2) a model with a constant and a lagged dependent variable. The forecast evaluation statistics are provided in Table 4 for the three models. The results suggest that the tourism demand model estimated earlier outperforms its two naive counterparts over both short and long horizons. Indeed over a four year horizon, the MAE for the tourism demand model almost half that of the next best model, with most of the forecast error due to unsystematic error.

Table 4: Forecast Evaluation Statistics (2001-2004)

	1-year Horizon			2-year Forecasting Horizon			4-year Forecasting Horizon		
	M1	M2	M3	M1	M2	M3	M1	M2	M3
RMSE	1.074	0.426	0.263	1.075	0.572	0.278	1.064	0.789	0.331
MAE	0.643	0.214	0.197	0.641	0.283	0.211	0.668	0.434	0.246
Theil	0.044	0.017	0.011	0.044	0.023	0.011	0.044	0.032	0.013
Cov. Prop.	0.678	0.833	0.681	0.679	0.812	0.695	0.657	0.743	0.725

Notes: M1 is a model with only a constant, M2 is a model with only a constant and lagged dependent variable, while M3 is the tourism demand model estimated earlier.

4.2 Forecasted Impact of Climate Change

The forecast evaluation statistics provided above therefore imply that the tourism demand model can be employed to forecast the impact of changes in tourism features likely to emanate from climate change. Utilising estimates of climate change on the four most likely climate scenarios, the projections for the impact of climate change on tourism demand for particular destinations is provided in Table 5. The table shows that the four climate change scenarios are quite heterogeneous: while the A1 and A2 scenarios suggest some slight improvement in tourism demand due to changes in climatic features in the Caribbean, the B1 and B2 scenarios suggest that the regional tourist industry could contract by about 1.2 percent per year due to climatic shifts. This decline translates to an approximate loss of between US$118 million to US$146 million in tourist expenditure for the regional industry. The main factor driving the decline in tourist arrivals under the B1 and B2 scenarios is the projected rise in temperature that would make normal tourist activities fairly difficult to do during the day.

The impact of climate change on individual countries is also likely to be fairly heterogeneous. Some countries such as Dominica, the Dominican Republic, Haiti, St. Kitts-Nevis and Suriname are projected to experience some increase in tourism demand under all four climate change scenarios, while arrivals to St. Lucia are likely to decline marginally under all four scenarios.

Table 6: Projected Annual Growth in Tourist Arrivals (2071-2100)

Country	% Deviation from Baseline			
	A1FI	*A2*	*B1*	*B2*
Antigua	2.203	2.203	-0.112	-0.112
Aruba	2.694	2.694	-3.732	-3.732
Barbados	0.491	0.491	-0.154	-5.935
Bermuda	0.449	0.449	-5.977	-4.694
British Virgin Islands	2.203	2.203	-0.112	1.171
Cayman Islands	2.203	2.203	-0.112	1.171
Dominica	7.597	7.597	1.171	1.171
Dominican Republic	6.391	7.597	1.171	1.171
Grenada	2.016	2.016	-4.410	-4.410
Haiti	2.694	2.694	1.171	1.171
Jamaica	2.203	2.203	-5.693	-5.693
Montserrat	6.315	6.315	-0.112	-0.112
St. Kitts	7.597	8.803	2.377	2.377
St. Lucia	-0.048	-0.048	-0.247	-0.247
St. Vincent	2.377	2.377	-4.049	-4.049
Suriname	7.597	7.597	2.640	2.640
Trinidad and Tobago	3.019	1.370	-5.057	-5.057
Average	*3.222*	*3.265*	*-1.180*	*-1.287*
Change in Total Tourist Expenditure (2004 $)	*321.035*	*356.386*	*-118.208*	*-146.099*

5. Conclusions

The Caribbean tourism industry has been the main engine of growth and job creation for the region for a number of years. It is therefore important to assess and develop potential strategies to counter any potential threats to the industry. One potential threat to the future viability of the tourist industry indentified in recent years is climate change. Climate change has the potential to impact on both the supply- and demand-sides of the regional tourist product. On the supply-side, the increased frequency and intensity of tropical storms could impact on the hotel plant as well as tourist attractions, while on the demand demand-side a change in climatic features could lead to a shift in visitor patterns.

This study provides an assessment of the potential impact of a change in the region's climatic features could have on tourism demand. A standard model of tourism demand is estimated using a database containing information on arrivals and key explanatory variables for 18 Caribbean countries. The model is estimated using data over the period 1980 to 2004 in a panel error correction model with fixed cross country effects. The coefficient estimates of the model were in general agreement with previous tourism demand studies. In addition, the model outperformed two naive models in an out-of-sample forecasting exercise conducted over the 2001 to 2004 period.

Using data on the region's likely climatic future under four scenarios, the tourism demand model was employed to simulate the impact of changes in climatic features on regional arrivals. The results suggest that in the worst case scenarios arrivals to the Caribbean could fall by about 1 percent per year due to the effects of climate change, costing the region about US$118 million to US$146 million in lost revenue per annum. These results were, however, not homogenous. Some Caribbean countries were likely to be more affected by climate change than others. For example, under worst case scenarios arrivals to three Caribbean islands (Bermuda, Jamaica and Trinidad and Tobago) could fall by about 5 percent per year due to the effects of climate change.

One shortcoming of this paper is that it ignores the potential reduction in tourism demand. For example, if the region is also subject to a higher frequency of hurricanes and other natural disasters due to a perceived hike in the risk of travelling to the region. In addition, the demand for the region's product could be affected if climate change leads to land loss, a reduction in biodiversity as well as damage to the hotel plant. Measures put in place to stem the negative effects of climate change such as higher travel taxes could also have implications for long haul trips to the Caribbean.

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