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Perfect Storm: Climate Change and Tourism

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Perfect Storm: Climate Change and Tourism

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Abstract

While the world's attention is on dealing with the COVID-19 pandemic, climate change remains a greater existential threat to vulnerable countries that are highly dependent on a weather-sensitive sector like tourism. Using a novel multidimensional index, this study investigates the long-term impact of climate change vulnerability on international tourism in a panel of 15 Caribbean countries over the period 1995–2017. Empirical results show that climate vulnerability already has a statistically and economically significant negative effect on international tourism revenues across the region. As extreme weather events are becoming more frequent and severe over time, our findings indicate that the Caribbean countries need to pursue comprehensive adaptation policies to reduce vulnerabilities to climate change.

JEL Classification Numbers: O44; Q51; Q54

Keywords: Climate change; global warming; tourism; adaptation; resilience; Caribbean

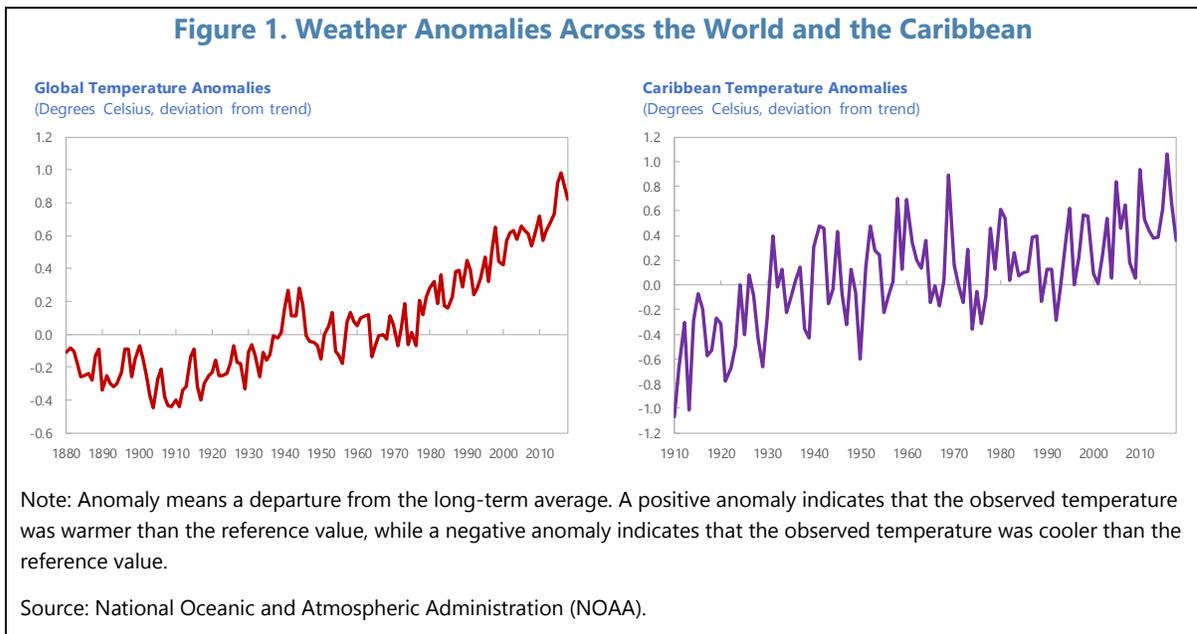
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I. INTRODUCTION

While the world is struggling to bring the COVID-19 pandemic under control, climate change remains a greater existential threat, especially to vulnerable countries that are highly dependent on a weather-sensitive sector like tourism. With the global average surface temperature rising by 1.1 degrees Celsius since 1880, the frequency of extreme weather events and large-scale disasters has increased across the world (Figure 1). At the same time, the global average sea level in the ocean has increased by 21-24 centimeters, with about a third of that occurring in just the last two and a half decades. Although causal linkages may not follow a path that is easy to trace, the evidence on climate change is already unequivocal. Looking forward, extreme weather events are projected to worsen with the global annual mean temperatures increase by as much as 4 degrees Celsius over the next century and global mean sea level is likely to rise at least 30 centimeters above 2000 levels (IPCC, 2007; Stern, 2007; IPCC, 2014; IPCC, 2019).² As one of the main challenges of the 21st century, the economic consequences of a changing climate will be felt across the world. But vulnerability of employment and income to weather-related shocks is greatest in countries that are highly dependent on a single climate-sensitive sector of the economy such as tourism and with tourism activities reliant on vulnerable natural resources such as beaches and coral reefs.



The Caribbean stands out with the climate-sensitive tourism industry accounting for 20 to 90 percent of GDP, and on average 30 percent of employment. Consisting of mostly small islands, the region is one of exceptionally natural disaster-prone regions in the world, with hurricanes

² Climate refers to a distribution of weather outcomes for a given location, and climate change describes environmental shifts in the distribution of weather outcomes toward extremes.

causing extensive economic damages during the annual Atlantic storm season (Rhiney, 2015; Acevedo, 2016; Stennett-Brown, Stephenson, and Taylor, 2019; Veron and others, 2019).³

The rise in temperatures, sea levels and hurricanes intensity make climate shocks more frequent and severe over time, but also equally importantly, uncertain in nature. Tourism infrastructure is consequently vulnerable to hurricanes and coastal inundation throughout the Caribbean region, with about 95 percent of accommodation facilities and 80 percent of tourist attractions located at sea level along the coast.⁴ Furthermore, degradation of natural assets such as coral reefs and the reduction in available surface water due to changes in rainfall and increased droughts are significant threats to tourism activity.

It is well established in the literature that extreme weather events and natural disasters tend to impair economic activity, especially in developing countries with weaker capacity to mitigate and adapt. In this paper, however, we move beyond the usual dummy variable for natural disasters and utilize a novel multidimensional index developed by the Notre Dame Global Adaptation Institute (ND-GAIN) to measure climate change vulnerability. The main contribution of this study is therefore to empirically investigate the long-term impact of climate change on international tourism in a panel of 15 Caribbean counties over the period 1995–2017.

The empirical analysis shows that climate change vulnerability is already negatively associated with international tourism revenues across the Caribbean region. For example, a ten percentage-point increase in climate change vulnerability leads to a decline of 9 percentage points in tourism earnings per visitor (or a reduction of 10 percentage points in tourism revenues as a share of GDP), even after controlling for conventional macroeconomic and social factors including the level of income, relative prices, the crime rate, and government effectiveness. Furthermore, since the difference between the minimum and maximum levels of climate change vulnerability among Caribbean countries is 20 percentage points, a country with high-level of climate change vulnerability already earns about 18 percentage points less in tourism revenues compared to a country with a low-level of climate change vulnerability. These results, in our view, reflect the importance of environmental conditions in shaping visitors' attitudes toward risk and perception of safety in international travel and tourism, which will become even more critical over longer horizons with the intensifying frequency and severity of climate shocks.

These empirical findings provide strong evidence for a comprehensive action plan to improve structural resilience through comprehensive adaptation policies, strengthen financial resilience through fiscal buffers and insurance schemes, and improve economic diversification and policy

³ Small island states, defined as countries with a population of less than 1.5 million, are particularly vulnerable to weather-related natural disasters. In the Caribbean, the costs of Hurricane Ivan for Grenada in 2004 amounted to 148 percent of GDP and those of Hurricane Maria for Dominica in 2017 reached 260 percent, reflecting both the intensity and range of damage of extreme hurricanes and the relatively small size of these economies.

⁴ A recent study finds that a substantial share of the world's sandy coastline is already eroding, and climate change could exacerbate the situation and result in the near extinction of almost half of the world's sandy beaches by the end of century (Vousdoukas and others, 2020).

management throughout the Caribbean and other small island states, especially as extreme weather events are expected to become more frequent and severe over time. Even though the scope for diversification is limited in these countries with no economies of scale, there is abundant opportunity to increase the share of domestic input in consumption and production and move up on the value-added chain.

The remainder of this study is organized as follows. Section II provides an overview of the related literature. Section III describes the data used in the analysis. Section IV introduces the salient features of our econometric strategy. Section V presents the empirical results, including a series of robustness checks. Finally, Section VI offers concluding remarks with policy implications.

II. BRIEF OVERVIEW OF THE LITERATURE

This paper draws from two major threads of the literature—determinants of international tourism demand and economic impact of climate change and natural disasters. First, tourism demand for a destination is influenced by a variety of factors, including cultural, economic and social factors. Uysal (1998), Turner and Wit (2001) and Goh and Law (2003) show that both quantitative and qualitative factors, such as price, income, cultural and historical heritage, and advertising influence tourism activity. Zhang, Song, and Huang (2009) and Culiuc (2014) find that developed countries, with a larger share of global tourism flows, tend to have higher elasticity with respect to income and real exchange rates, while tourist flows to small island countries are less sensitive to macroeconomic developments. Focusing on international tourism flows to the Caribbean, Wolfe and Romeu (2011), Laframboise and others (2014), and Ghazanchyan and others (2019) conclude that tourist arrivals and expenditures are sensitive to income in source markets and price factors, although not in high-end destinations. Acevedo and others (2016), on the other hand, concentrate on the role of airlift supply on tourism and show that the number of flights from the U.S. is a principal factor influencing international tourist flows to the Caribbean.

Second, there is a flourishing literature on the economic impact of climate change.⁵ Following Nordhaus (1991; 1992) and Cline (1992), aggregate damage functions have become a mainstay of analyzing the climate-economy nexus. Although identifying the macroeconomic impact of annual variation in climatic conditions remains a challenging empirical task, Gallup, Sachs, and Mellinger (1999), Nordhaus (2006), and Dell, Jones, and Olken (2012) find that higher temperatures result in a significant reduction in economic growth in developing countries. Burke, Hsiang, and Miguel (2015) confirm this finding and conclude that an increase in temperature would have a greater damage in countries that are concentrated in geographic areas with hotter climates. Using expanded datasets, Acevedo and others (2018), Burke and Tanutama (2019) and Kahn and others (2019) show that the long-term macroeconomic impact of weather anomalies is uneven across countries and that economic growth responds nonlinearly to temperature.

These empirical findings are also consistent with studies focusing on the impact of natural disasters in developing and smaller countries, which are significantly more vulnerable to weather-

⁵ Tol (2018) provides a recent overview of this expanding literature.

related disasters (Noy, 2009; Ouattara and Strobl, 2013; Bhati, Upadhyaya, and Sharma, 2016). Investigating the Caribbean region, Rasmussen (2004) finds that natural disasters result in a significant loss in output and a deterioration in external and fiscal balances in the short term, while these effects are inconclusive in the long run. Similarly, Cashin and Sosa (2013), Mora and others (2017), and Aja and others (2018) show that climatic shocks lead to an immediate and substantial decline in output, as well as a prolonged period of humanitarian emergency, especially in small states and throughout the Caribbean region.

More specifically, with regards to the impact on tourism, a number of studies have found adverse consequences of climate change in coastal cities and island states (Lise and Tol, 2002; Scott, McBoyle, and Schwartzentruber, 2004; Belle and Bramwell, 2005; Meheux, Dominey-Howes, and Lloyd, 2007; Atzori, Fyall, and Miller, 2018; ; Dogru and others, 2019; Scott, Hall, and Gössling, 2019). Looking at the impact of hurricanes on tourist flows to the Caribbean, Granvorka and Strobl (2013) find that an average hurricane strike causes tourism arrivals to be about 2 percent lower than they would have been had no hurricane occurred.

III. DATA OVERVIEW

We focus on a sample of 15 Caribbean countries and employs an unbalanced panel of annual observations over the period 1995–2017.⁶ We assemble economic and social statistics from the IMF’s International Financial Statistics (IFS) and World Economic Outlook (WEO) databases, and the World Bank’s World Development Indicators (WDI) database. Our dependent variable is international tourism receipts per visitor, calculated as the ratio of annual tourism earnings to the number of international visitors (or as a share of GDP).

The main explanatory variable of interest is climate change vulnerability as measured by a composite index developed by the ND-GAIN.⁷ The ND-GAIN vulnerability index captures a country’s overall susceptibility to climate-related disruptions, based on 36 variables covering 6 life-supporting sectors—food, water, health, ecosystem services, human habitat and infrastructure. The index takes into account: (i) the degree to which a country is exposed to significant climate change from a biophysical perspective independent of socio economic context; (ii) the extent to which a country is dependent upon a sector negatively affected by climate change, or the proportion of the population particularly susceptible to climate change; and (iii) the availability of social resources for sustainable adaptation solutions. Following the literature, we include real GDP per capita, the real effective exchange rate (REER), crime measured by the number of homicides per 100,000 inhabitants, and a composite index of government effectiveness as control variables.

⁶ The countries included in the sample are Antigua and Barbuda, The Bahamas, Barbados, Belize, Dominica, Dominican Republic, Grenada, Guyana, Haiti, Jamaica, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname, and Trinidad and Tobago.

⁷ The ND-GAIN database, covering 184 countries over the period 1995–2017, is available at <https://gain.nd.edu/>.

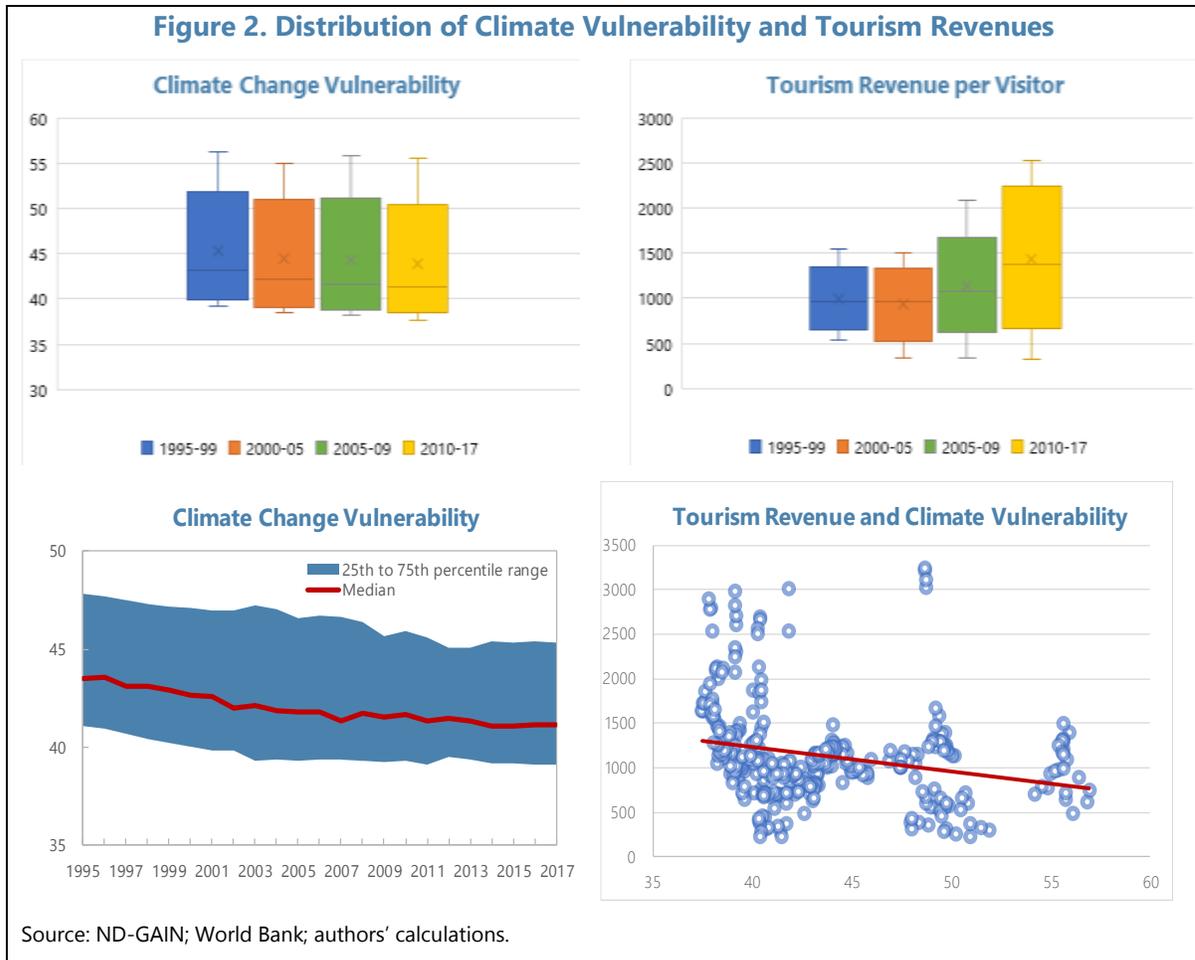


Table 1. Summary Statistics

Variables	Obs.	Mean	Std. Dev.	Min.	Max.
Tourism revenues per visitor	365	1139.3	542.8	219.4	3240.0
Tourism revenues as a share of GDP	368	3.1	11.6	0.0	68.3
Real GDP per capita	368	8790.2	6852.9	662.3	32080.4
Climate vulnerability index	368	0.43	0.05	0.37	0.57
REER	345	99.5	12.5	51.6	132.4
Crime	263	19.8	12.6	1.4	65.4
Government effectiveness	263	0.3	0.5	-0.7	1.6

Source: IMF; ND-GAIN database; World Bank; authors' calculations.

Descriptive statistics for the variables used in the empirical analysis are presented in Table 1. There is a significant degree of dispersion across the Caribbean countries in terms of international tourism earnings per visitor and considerable heterogeneity in climate change vulnerability in spite of the geographical and institutional proximity of these countries (Figure 2). While the ND-GAIN vulnerability score is a slow-moving index as expected, it shows significant variation across countries and over time. It is interesting to observe that climate change

vulnerability improved among Caribbean countries between 1995 and 2017, with the average climate change vulnerability index declining by 1.95 percent. This improvement—during a period of increasing number and intensity of extreme weather events—is mainly due to advances in adaptive capacity. However, the rate of change still varies from a minimum of 0.38 percent to a maximum of 3.40 percent. Furthermore, relative to the U.S., Caribbean countries remain almost twice as vulnerable to climate change. Finally, we examine the time-series properties of the panel data to prevent spurious findings by performing unit root tests, in particular the Im-Pesaran-Shin (2003) procedure, and find that the variables are stationary after logarithmic transformations.

IV. EMPIRICAL METHODOLOGY

We study the impact of climate change vulnerability on international tourism—measured by revenue per visitor or as a share of GDP—by applying alternative specifications and estimation methodologies. The static model is presented as a point of reference, but the dynamic model of tourism is our baseline specification in the following form:

$$tur_{ct} = \beta_1 + \beta_2 tur_{ct-1} + \beta_3 vul_{ct} + \beta_4 X_{ct} + \eta_c + \mu_t + \varepsilon_{ct}$$

Where the dependent variable, tur_{ct} , is the measure of international tourism receipts in country c and time t ; vul_{ct} denotes the multidimensional index of climate change vulnerability; X_{ct} is a vector of control variables including real GDP per capita, the REER, the crime rate, and a composite index of government effectiveness. The η_c and μ_t coefficients designate the time-invariant country-specific effects and the time effects controlling for common shocks that may affect international tourism revenue per visitor (or as a share of GDP) across all countries in a given year, respectively. ε_{ct} is an idiosyncratic error term that meets the standard assumptions of zero mean and constant variance. To account for possible heteroskedasticity, robust standard errors are clustered at the country level.

We present the estimation results based on the standard fixed effects model, but the country-specific effects combined with the lagged dependent variable in the model creates an estimation bias when the traditional least squares estimator is used due to correlation between the error term and the lagged dependent variable in the transformed model. Therefore, we use the system Generalized Method of Moments (GMM) estimator developed by Arellano and Bover (1995) and Blundell and Bond (1998). The system GMM technique involves constructing two sets of equations, one with first differences of the endogenous and pre-determined variables instrumented by suitable lags of their own levels, and one with the levels of the endogenous and pre-determined variables instrumented with suitable lags of their own first differences. We apply the one-step version of the system GMM estimator to ensure the robustness of the results, as the standard errors from the two-step variant of the system GMM method are shown to have a downward bias in small samples.

Using all available lagged levels of the variables in the system GMM estimation results in an instrument proliferation, which in turn reduces the efficiency of the estimator and potentially leads to over-fitting. Also, the use of a large set of instruments weakens the Hansen J -test of

over-identifying restrictions, making it difficult to detect over-identification problems over loss of information. Accordingly, estimating such models requires a subtle balance between maximizing the information obtained from the panel data, and safeguarding against over-identification. We follow Roodman (2009) to address this issue. We also corroborate the system GMM identification assumptions by performing a second-order serial correlation test for the residuals and the Hansen J -test for the overidentifying restrictions. The values reported for AR(1) and AR(2) in Table 1 for the baseline estimation results and Table 2 for the robustness checks are the p -values for first- and second-order autocorrelated disturbances in the first-differenced equation. As expected, there is high first-order autocorrelation, but no evidence for significant second-order autocorrelation. Likewise, the Hansen J -test result indicate the validity of internal instruments used in the dynamic model estimated via the system GMM technique.

V. ESTIMATION RESULTS

Table 2 presents the baseline findings, which indicate a strong fit of the model to the dataset. Since the potential presence of correlation between the unobserved country-specific effects and the lagged dependent variable may render the fixed-effects estimation approach inappropriate, our focus is on the empirical results obtained via the system GMM approach. Comparison of estimated coefficients for the explanatory variables indicates that most of these factors significantly contribute to a country's performance in international tourism, but some have a greater marginal effect than others. Real GDP per capita and government effectiveness have positive effects on international tourism earnings, while countries with higher relative prices and crime experience lower tourism receipts as expected.

With regards to our main variable of interest, we find that the coefficient on climate change vulnerability is negative and statistically significant. This observation indicates that countries with greater vulnerability to climate change typically generate lower international tourism receipts per visitor (or as a share of GDP) in our sample of 15 Caribbean countries during the period 1995–2017. The magnitude of estimated coefficients suggests that climate change vulnerability is more important than other factors associated with international tourism performance. Looking at the size of elasticity in the dynamic model, for example, a ten percentage-point increase in climate change vulnerability is associated with about 9 percentage-point decline in international tourism earnings per visitor. This adverse effect of climate change vulnerability remains economically and statistically significant when we measure tourism revenues as a share of GDP, resulting in a reduction of 10 percentage points as shown in Table 3.

In other words, greater vulnerability to climate change lowers international tourism receipts in our sample of Caribbean countries, even after controlling for conventional macroeconomic and social factors (such as the level of income, relative prices, crime, and government effectiveness) as well as a high degree of persistence in international tourism demand over time. This is not a surprising finding, since environmental conditions tend to be an important factor shaping visitors' attitudes toward risk and perception of safety in international travel and tourism.

The size of this negative impact on international tourism earnings is already economically significant when comparing one year to the next that are becoming more vulnerable to climate change, and with the intensifying frequency and severity of climate shocks, the cumulative effect of climate change on tourism will likely be significantly greater over longer horizons. Furthermore, the difference between the minimum and maximum levels of climate change vulnerability among Caribbean countries is 20 percentage points, which implies that a country with high-level of climate change vulnerability earns about 18 percentage points less in tourism revenues compared to a country with a low-level of climate change vulnerability. Accordingly, this pattern of empirical findings underscores the criticality of adaptation measures designed to strengthen physical, financial, and institutional resilience against climate change, especially in tourism-dependent economies.

Table 2. Baseline Estimations—Climate Change and Tourism

	Fixed Effects	System GMM
Tourism revenue _{t-1}	0.695*** [0.052]	0.846*** [0.047]
Climate vulnerability	-1.716 [3.629]	-1.117*** [0.577]
Real GDP per capita	0.209 [0.208]	0.068*** [0.048]
REER	0.001 [0.002]	-0.003* [0.003]
Crime	-0.001 [0.001]	-0.001* [0.001]
Government effectiveness	0.085 [0.056]	0.048 [0.039]
Number of observations	241	241
Number of countries	15	15
Country FE	Yes	Yes
Year FE	Yes	Yes
Adj R ²	0.79	
AR1 <i>p</i> -value		0.003
AR2 <i>p</i> -value		0.900
Hansen <i>J</i> -test <i>p</i> -value		0.220

Note: The dependent variable is tourism revenue per visitor. Robust standard errors, clustered at the country level, are reported in brackets. A constant is included in each regression, but not shown in the table. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

We conduct a number of robustness checks to validate our baseline empirical findings. First, we truncate the sample at the 5th and 95th percentiles to exclude outliers. Second, we use international tourism receipts as a share of GDP as an alternative measure. Third, we use the occurrence of natural disasters according to the EM-DAT database as an alternative measure of climate vulnerability. Even though it is not a forward-looking indicator like the ND-GAIN index, the EM-DAT series still captures the historical vulnerability of Caribbean countries to weather-related natural disasters, which will remain the main channel of climate change vulnerability for these countries in the future. These results, presented in Table 3, show that the negative and economically significant relationship between climate change vulnerability and international tourism revenue remains unchanged in our sample of 15 Caribbean countries during the period 1995–2017, with some minor changes in the magnitude of estimated coefficients.

Table 3. Robustness Checks—Climate Change and Tourism

System GMM			
	Truncated sample	Alternative measure of tourism revenue	Alternative measure of climate vulnerability
Tourism revenue _{t-1}	0.822*** [0.057]	0.993*** [0.017]	0.858*** [0.116]
Climate vulnerability	-0.695*** [0.185]	-0.690*** [0.031]	-0.018*** [0.121]
Real GDP per capita	0.065*** [0.135]	0.054*** [0.120]	0.026*** [0.112]
REER	-0.003* [0.002]	-0.002* [0.002]	-0.003* [0.003]
Crime	-0.001* [0.001]	-0.001* [0.001]	-0.002* [0.001]
Government effectiveness	0.042 [0.035]	0.055 [0.040]	0.026 [0.074]
Number of observations	220	144	146
Number of countries	15	15	15
Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
AR1 <i>p</i> -value	0.001	0.000	0.000
AR2 <i>p</i> -value	0.820	0.585	0.803
Hansen <i>J</i> -test <i>p</i> -value	0.188	0.169	0.225

Note: The dependent variable is inflation as defined in Section III. Robust standard errors, clustered at the country level, are reported in brackets. A constant is included in each regression, but not shown in the table. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

VI. CONCLUSION

We assess the impact of climate change vulnerability on international tourism receipts in a panel of 15 Caribbean countries that are highly dependent on tourism as the main engine of income and employment growth. Instead of the usual dummy variable for natural disasters or a single-issue variable like a measure of hurricane intensity, we utilize a novel multidimensional index to measure climate change vulnerability across countries and over time. The empirical evidence confirms that international tourism revenues across the Caribbean region are adversely affected by greater vulnerability to climate change and that the impact of climate vulnerability is already economically significant and more important than other factors associated with the performance in international travel and tourism.

On average, a ten percentage-point increase in climate change vulnerability is associated with a decline of 9 percentage points in tourism earnings per visitor (or a reduction of 10 percentage points in tourism revenues as a share of GDP) in our sample of Caribbean countries, even after controlling for conventional macroeconomic and social factors. Moreover, since the difference between the minimum and maximum levels of climate change vulnerability among Caribbean countries is 20 percentage points, a country with high-level of climate change vulnerability already earns about 18 percentage points less in tourism revenues compared to a country with a low-level of climate change vulnerability. These results, in our view, is a manifestation of environmental conditions that shape visitors' attitudes toward risk and perception of safety in international travel and tourism. Therefore, as extreme weather outcomes are set to become more frequent and severe over time, our findings of strong negative relationship between climate change vulnerability and international tourism revenues indicate a larger economic impact of climate-related shocks—from devastating hurricanes to rising sea level—in the future.

The economic fallout from the COVID-19 pandemic has shown the need for economic diversification in extremely tourism-dependent economies in the Caribbean. While that is an important long-term policy objective, the region is a top destination for millions for tourists each year and tourism will remain the main engine of economic growth and job creation. Therefore, increasing the global market share will require far-reaching structural reforms and reprioritizing public investments to improve resilience against climate change. The empirical analysis presented in this paper provides robust evidence for a comprehensive action plan to enhance competitiveness and structural resilience through comprehensive adaptation measures, strengthen financial resilience through fiscal buffers and insurance schemes, and improve economic diversification and policy management throughout the Caribbean and other small island states (IMF, 2016; Alleyne and others, 2017; IMF, 2017; IMF, 2019). Although the scope for diversification is limited in these countries with no economies of scale, there is abundant opportunity to increase the share of domestic input in consumption and production and move up on the value-added chain in tourism and other sectors such as agriculture and fisheries.

In the case of Caribbean countries, most climate change adaptation measures are undertaken in coastal zones and to protect water resources and the agriculture sector and focus on improving

institutions, governance and planning to primarily ensure physical resilience and food security (Adger and others, 2011; Hughes 2013; Shah and Dulal, 2015; Robinson, 2018). Accordingly, many adaptation actions in the Caribbean have been geared towards reducing vulnerability and advancing adaptive capacity by improving climate-related knowledge and “strengthening socio-economic systems and livelihoods” (Tompkins 2005; Hay, 2013). The single most reported adaptation measures is vulnerability and impact assessments, which account for 10 percent of all adaptation actions throughout the Caribbean (Robinson, 2018). As shown by climate vulnerability assessments, these countries need to develop a more comprehensive adaptation strategy, which continues to be constrained by financing, technical capacity and human resources, especially in the post-pandemic world. This will require enhancing investment in physical infrastructure and technology, strengthening education and labor skills, and creating a more nurturing business environment to promote entrepreneurship.

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