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Flying to Paradise: The Role of Airlift in the Caribbean Tourism Industry

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Abstract

This paper studies the role of airlift supply on the tourism sector in the Caribbean. The paper examines the relative importance of U.S.-Caribbean airlift supply factors such as the number of flights, seats, airlines, and departure cities on U.S. tourist arrivals. The possible endogeneity problem between airlift supply and tourist arrivals is addressed by using a structural panel VAR and individual country VARs. Among the four airlift supply measures, increasing the number of flights is found to be the most effective way to boost tourist arrivals on a sustained basis. As a case study, the possible crowding effect of increasing the number of U.S. flights to Cuba is investigated and, based on past observations, we find no significant impact on flights to other Caribbean countries. The impact of natural disasters on airlift supply and tourist arrivals is also quantified.

JEL Classification Numbers: C32, C33, L83, N16, O54.

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I. INTRODUCTION

This study examines the role of airlift supply on the tourism sector in the Caribbean. The answer to this may seem intuitive and obvious: more airlift will benefit any tourism destination, particularly destinations such as those in the Caribbean—mostly islands that can only be reached by airplane or boat. What is not immediately obvious, however, is what factors of airlift supply have the largest impact on tourism flows, and why this might be important for policymakers.

One could argue that the most important factor is having many rival airlines, which would keep ticket prices competitive. Tourists, on the other hand, might place greater value on having non-stop flights to their destination. Alternatively, a minister of tourism in the Caribbean might be more interested in sheer volume, i.e., frequency of flights and number of seats. Or one could simply conclude that all factors are equally important.

This paper seeks to determine the relative importance of different airlift supply factors for U.S tourist arrivals to the Caribbean, namely the number of flights, seats, airlines, and departure cities with non-stop flights. The topic is relevant given the time and resources that Caribbean governments spend engaging the airline industry to provide more and better services to their destinations. The paper aims to provide objective evidence on key elements of airlift that Caribbean authorities can use in their dealings with airlines, and in developing their tourism development strategies.

We study the impact that different airlift supply factors have on tourism flows from the U.S.. We concentrate on the U.S. because of the availability of detailed data from the U.S. Bureau of Transportation Statistics on all international segments of flights that depart or land in U.S. territory. The database contains monthly information on the number of flights, seats, passengers, the type of aircraft, and the airline, for each route connecting the U.S. with a foreign territory. This rich dataset allows us to answer the question of what is the best method to improve airlift supply to the Caribbean? As the U.S. is by far the biggest tourism market for the Caribbean, there is no loss of generality by concentrating on the U.S.-Caribbean airlift.

The possible endogeneity problem between airlift supply and tourist arrivals is addressed by using a structural panel VAR approach. We also estimate country-by-country structural VARs to explore the heterogeneity across countries. Among the four airlift supply factors (number of airlines, departure cities, flights and seats), increasing the number of flights is found to be the most effective method to boost tourist arrivals. As a case study, we investigate the possible crowding effect of increasing the number of U.S. flights to Cuba and find no significant impact on flights to other Caribbean countries, based on past observations. We also quantify the impact and persistence of natural disasters on airlift supply and tourist arrivals, where we find not surprisingly that severe natural disasters have a large and negative impact on tourism flows.

The paper is structured as follows: Section II provides a short survey of the relevant literature; Section III presents some stylized facts drawing on the rich dataset of U.S. flights; Section IV presents the model and the other data used; and Section V presents the main findings. Section VI concludes and discusses some policy implications.

II. Literature Review

This paper studies tourist arrivals in the Caribbean region with a focus on airlift supply-side determinants. In the existing tourism literature, demand-side determinants are identified as: source countries' income and unemployment rates, relative prices and the exchange rate, and some other external shocks (Witt and Witt, 1992; Crouch, 1994a; Zhang, 2009; Culiuc, 2014). Supply-side determinants often include the number of flights, number of hotel rooms, and foreign direct investment (FDI).

Demand-side determinants of tourism flows, both global and Caribbean-specific, have been extensively studied. Culiuc (2014), based on a gravity model, found that source countries' income and real exchange rate, and bilateral trade flows have a strong impact on world tourist arrivals, although the impact is much reduced on smaller countries. Wolfe and Romeu (2011) reached similar conclusions. Their study measured the impact of economic conditions in OECD countries on tourist arrivals to Latin America and the Caribbean. Generally, they found that the impact of income and prices on tourism varies by country, the period of the study, and the type of variable used (Crouch, 1994a; Athiyaman, 1997). Caribbean-specific research has reported similar findings, complemented by country-specific factors. For instance, Laframboise *et al* (2014) showed that tourism flows to high-end destinations are price inelastic. They also identified structural changes after the global financial crisis, noting that price factors had become insignificant while income factors were more sensitive.

A number of recent Caribbean specific studies have attempted to explore the role of supply-side factors on tourism flows. Based on panel OLS using annual data, Laframboise *et al* (2014) showed that a 1 percent increase in the number of flights is associated with about 0.1 percent increase in tourist arrivals, with no significant impact from hotel room stocks. Similarly, Tsounta (2008) found that FDI and the number of flights positively affect tourism flows with similar magnitudes. The estimates show that a 1 percent increase of these supply factors—FDI and number of flights—is found to increase tourist arrivals by 0.08 percent for both variables. Mwase (2013) used hotel room stock as a proxy for supply factors and found that a 1 percent increase in the number of rooms tends to increase tourist arrivals by about 0.9 percent.

Paper	Variable (1 percent increase)	Magnitude	Countries in the Sample
Culiuc (2014)	Number of Flight	↑ 0.2–0.9 (varies by model)	World
	Hotel Room	↑ 0.1–0.4 (varies by model)	World
Laframboise *et al* (2014)	Number of Flights	↑ 0.08–0.1 percent	Caribbean countries
	Hotel Room	– Not significant	Caribbean countries
Mwase (2013)	Hotel Room	↑ 0.9 percent	ECCU
Tsounta (2008)	Number of Flights	↑ 0.08 percent	ECCU
	FDI	↑ 0.08 percent	ECCU

These results are broadly consistent with our findings: a 1 percent increase in the number of flights is associated with an immediate 0.3 percent increase in tourist arrivals, which rises to 1 percent over one year. Previous studies accounted for reverse causality (i.e., endogeneity issues) from tourist arrivals to supply factors by mostly including lag variables. However, the use of annual data fails to capture the immediate impact of supply factors on tourism flows. In addition, using lagged variables will not help explain the impact of a change in tourist arrivals independent of *concurrent* changes in supply factors. This paper attempts to overcome these issues and fill the gap in the literature by using a "micro dataset".

In particular, a unique micro dataset with highly disaggregated monthly flight information between the U.S. and the Caribbean is used to investigate the dynamics between tourist arrivals and airlift supply factors. The airlift supply data used includes number of flights, number of passengers, size of airplane, number of airlines, and associated U.S. departure cities with non-stop flights to the Caribbean. To our knowledge, there has been no study examining the impact of various airlift supply factors on tourism flows. The availability of high frequency data enables us to use a structural vector autoregressive model (SVAR) to disentangle the causality between airlift supply factors and tourism flows, addressing the endogeneity problem that exists in the literature. In particular, the model allows us to measure the change in supply factors independent of a change in tourist arrivals.

III. Stylized Facts

This section discusses the recent tourism performance in the Caribbean region.[1] The tourism sector has recovered since the global financial crisis, with total arrivals as well as arrivals from the U.S. growing by 20 percent since 2009. Since early 2000, the share of U.S. tourists has increased by 3 percentage points to about 51 percent of the total in 2014. In some countries, such as Aruba, the Bahamas, Cancun, Jamaica, and St. Kitts and Nevis, U.S. tourists make up over 60 percent of total arrivals.

The number of flights departing from the U.S. to the Caribbean has also picked up somewhat since the financial crisis, although they have grown slower compared to U.S. flights to the rest of the world. While the number of flights to the Caribbean increased by 8 percent, U.S. flights to the rest of world grew by 22 percent. Beyond the aggregate numbers, considerable heterogeneity exists across the region. Flights to Cancun, the Dominican Republic, and Jamaica, which combined account for almost half of total flights to the Caribbean in our sample, have been increasing faster than those to other tourism-based countries. In contrast, flights to Antigua and Barbuda, the Bahamas, and Barbados declined by almost 50 percent since mid-2000.[2] In 2014, Cancun and the Dominican Republic received the most number of flights, over 2,000 per month on average (Table 1).

Despite the relatively slow recovery in the number of flights to the region, the growth of passengers has been more than double that of flights due to declining vacancy rates (Figure 1, left chart).[3] Since 2000, vacancy rates have declined from about 40 percent, or 90 passengers per plane, to 25 percent in 2014, or over 100 passengers per plane (Figure 1, right chart). As

[1] All the numbers refer to our sample of 14 Caribbean destinations listed in Table 1.

[2] Both Antigua and Barbuda and Barbados have historically served as connecting hubs for the Easter Caribbean sub-region. As airlift availability to the rest of the Caribbean has improved over time, with more direct connections and more frequent flights, their hub services have dwindled and their flight traffic has declined accordingly.

[3] We define the vacancy rate as empty seats as a percent of total available seats.

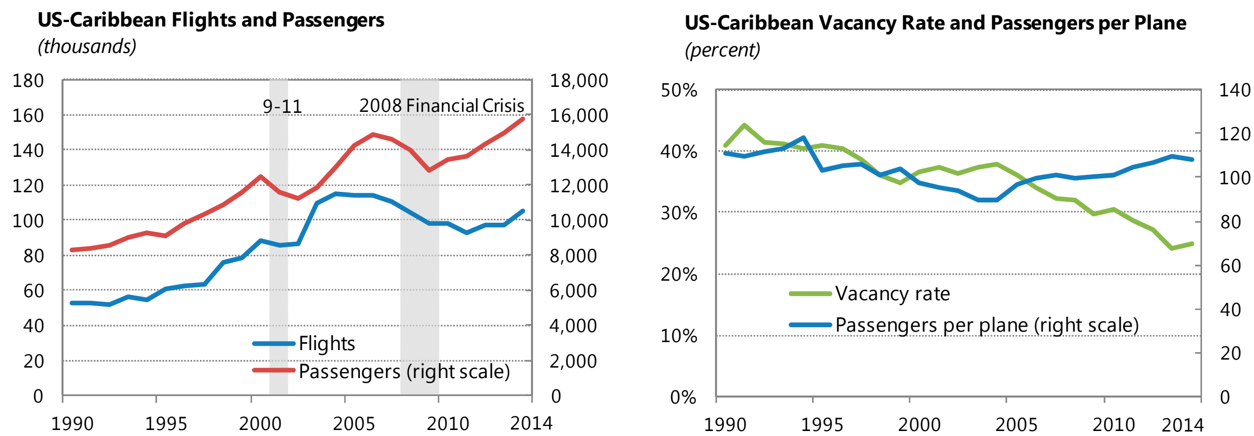
expected, airplanes flying to the major tourism destinations – Aruba, Barbados, Cancun, Dominican Republic, and Jamaica–are bigger, with over 150 seats on average.

Table 1. U.S.-Caribbean Airlift Availability, 2014

Country	ISO 3-letter code	Number of flights	Number of passengers	Plane size (avg.)	Departing US cities	Number of airlines	Vacancy rate
Antigua and Barbuda	ATG	1,028	119,732	153	4	4	24
Aruba	ABW	4,822	646,257	159	10	9	16
Bahamas, The	BHS	20,920	1,286,118	86	18	18	28
Barbados	BRB	1,306	197,440	178	3	4	15
Belize	BLZ	2,287	248,496	147	7	4	26
Bermuda	BMU	2,920	283,667	139	6	5	30
Cancun	CAN	25,360	3,426,071	160	33	14	16
Cayman Islands	CYM	4,005	400,035	139	11	6	28
Dominica	DMA	388	9,608	36	1	1	32
Dominican Republic	DOM	25,684	3,019,154	150	20	17	22
Grenada	GRD	440	54,427	154	2	3	19
Jamaica	JAM	13,327	1,591,018	151	16	12	21
St. Kitts and Nevis	KNV	1,621	84,198	74	5	6	30
St. Lucia	LCA	1,163	160,070	162	5	5	15

Source: Air Carrier Financial Reports from United States Department of Transportation; and authors' calculations.
The vacancy rate is defined as empty seats as a percent of all seats.

Figure 1. U.S.-Caribbean Airlift, 1990-2014



Source: Air Carrier Financial Reports from United States Department of Transportation; and authors' calculations.

For the purpose of this study, it is important to differentiate between the concepts of passengers and U.S. tourist arrivals (Figure 2). First, *U.S. tourist arrivals* are defined as U.S. residents who stay overnight in the host Caribbean country; they can travel directly from the U.S. to the destination (in which case they are counted as passengers in our data) or they can travel indirectly through connections in other countries. Second, *passengers* flying from the U.S. to the

Caribbean include not only U.S. tourists, but also tourists from other countries that make flight connections in the U.S., as well as Caribbean nationals.[4] For this reason, Antigua and Barbuda and Barbados, regional hubs, have more passengers than tourist arrivals, while Dominica has more U.S. tourists than passengers because some tourists travel to the island through regional connections and not directly from the U.S.. Cancun is a unique case because the number of passengers continues to grow while U.S. tourist arrivals remain flat. This might be caused in part by U.S. visitors flying to Cuba via Cancun in order to avoid U.S. travel restrictions, and in part by Cancun's airport serving as an entryway to other nearby Mexican destinations.

Figure 2. U.S. Tourist Arrivals versus Passengers

Source: Air Carrier Financial Reports from United States Department of Transportation; Caribbean Tourism Organization; and authors' calculations.

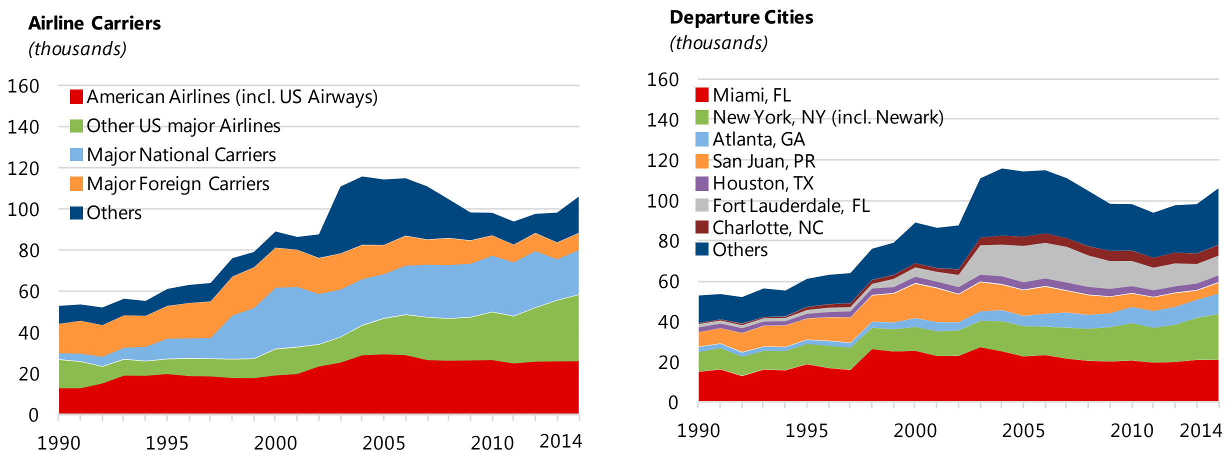
Most flights departing the U.S. for the Caribbean leave from Miami or other big cities. In particular, the biggest 10 cities source over 80 percent of flights and passengers to the region,

[4] Since the dataset used only includes direct flights between the U.S. and foreign airports, the data on the number of passengers also captures people in transit to other Caribbean destinations. That is, if a U.S. tourist is traveling to Dominica via a connecting flight in Antigua and Barbuda, it will be recorded as a passenger to Antigua and a U.S. tourist arrival to Dominica, but not as a tourist in Antigua or a passenger to Dominica.

Miami alone supplies 20 percent of flight departures. New York, Newark, and Atlanta have become important departure cities as San Juan's importance has subsided after American Airlines (AA) moved its Caribbean hub back to Miami starting in 2008 (Figure 3, right chart). In 2014, the most popular tourism destinations in the Caribbean had non-stop flights from about 20 U.S. cities.

AA is the primary airline serving the Caribbean, accounting for 20 percent of flights to the region. Other major U.S. carriers account for an additional 25–30 percent of all flights. National carriers and foreign carriers account for 20 percent each, with regional flights and small chartered flights explaining the rest (Figure 3, left chart)[5]. Certified carriers and commuter carriers typically fly to small and high-end tourism destination, such as Antigua and Barbuda, St. Kitts and Nevis, and Grenada.

Figure 3. U.S.-Caribbean Flights by Departing Cities and Airlines, 1990-2014



Source: Air Carrier Financial Reports from United States Department of Transportation; and authors' calculations.

Although the air travel market to the Caribbean as a whole is competitive, some individual destinations have high market concentration in a few airlines. The Herfindahl index, commonly used to measure market competition, shows a historically competitive market for the region as a whole.[6] However, most of the smaller destinations have high concentration of their air traffic connections with the U.S. leaving them vulnerable to services changes in a few airlines.[7] Despite

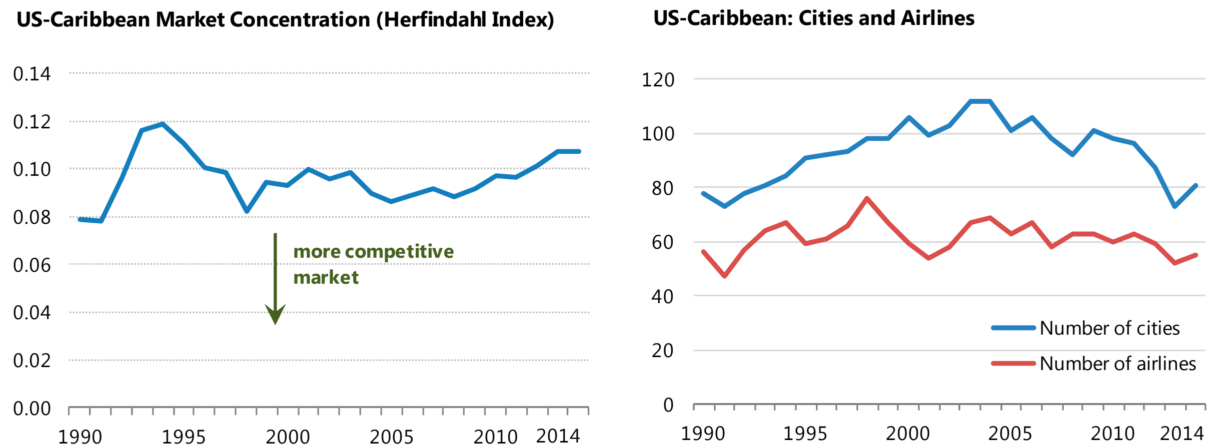
[5] Major carriers are defined as those with annual revenue over US$1 billion; national carriers have annual revenue between $100 million and $1 billion; regional carriers have annual revenue below $20 million; chartered certified carriers have a maximum seating capacity of 60 or less seats or a maximum payload of 18,000 pounds or less.

[6] The Herfindahl index is used to measure the size of firms in relation to the industry and to indicate concentration in an industry. In general, a measure below 0.01 indicates a "highly competitive market"; below 0.15 an "unconcentrated" market; and above 0.25 "high concentration".

[7] Countries with a Herfindahl index above 0.25 indicating high concentration include: Antigua and Barbuda, Barbados, Belize, Dominica, Grenada, St. Kitts and Nevis, and St. Lucia.

a seemingly strong reliance on major U.S. airlines, there are enough airlines flying to the region to ensure competition. Over the last 20 years, over 50 airlines on average have flown to the Caribbean region in any given year. While the overall number of airlines has been trending down recently, the most recent index value (below 0.15) still indicates a competitive market with no dominant player (Figure 4).

Figure 4. U.S.-Caribbean Airline Market Concentration, 1990-2014



Source: Air Carrier Financial Reports from United States Department of Transportation; and authors' calculations.

To better understand the availability of airlift in the Caribbean, particularly for the smaller islands, airlift supply factors are ranked per km^2 for all countries in the sample.[8] Table 2 shows that, after controlling for size, small islands have been at the top of the ranking in all categories of airlift supply, on average, over the past 20 years. In contrast, the major tourism destinations – namely the Bahamas, Dominican Republic, and Jamaica– ranked near the bottom, suggesting that the smaller islands are getting sufficient airlift for their tourism industry.[9] However, this could be partly the result of government subsidies to airlines, mostly in smaller islands, in the form of revenue or seats guarantees, joint marketing, etc.

The link between airlift and room capacity is important as the availability of one determines the availability of the other. However, a similar pattern is observed when one controls the availability of airlift for the number of hotel rooms (right panel of Table 2), with smaller countries ranking at the top. Notably, the biggest differences between the two rankings are for the Bahamas and Grenada; the latter goes from being among the top in airlift per km^2 to the bottom in airlift per hotel room, while the opposite is true for the Bahamas. This is related to the density of hotel rooms, with the Bahamas having the lowest hotel density in the region at one hotel room per km^2 and Grenada having the highest at close to 50 rooms per km^2.

[8] A superior gauge would be tourists per number of beaches, but the data is not available.

[9] A similar ranking in per capita terms also shows that small countries have good airlift supply from the U.S.

After a period of retrenchment following the global financial crisis, the volume of airlift and, more notably, the number of passengers from the U.S. to the Caribbean region, started increasing. More airlift options from the U.S. have become available: more flights are available from more U.S. cities and more airlines have resumed services. While a few key airlines lead the market, there appear to be a sufficient number of carriers and the U.S.-Caribbean airline industry is considered competitive. It is not clear what drives trends in supply factors—numbers of flights, airlines, departure cities, and size of plane. However, understanding the close linkage between disaggregated airline supply factors and tourist arrivals will help shed light on the importance of airlift supply in the region.

Table 2. Rankings of U.S. Airlift Availability in the Caribbean Controlling by Size (1990-2014)

Ranking of Airlift Availability per Land (km^2)

Ranking	Flight	Seats	Passengers	Airlines	Cities	Combined
1	BMU	BMU	BMU	BMU	BMU	BMU
2	ABW	ABW	ABW	GRD	ABW	ABW
3	GRD	GRD	GRD	ABW	GRD	GRD
4	CYM	CYM	CYM	CYM	CYM	CYM
5	CAN	AIA	AIA	KNA	KNA	AIA
6	AIA	CAN	CAN	AIA	CAN	CAN
7	KNA	KNA	KNA	ATG	AIA	KNA
8	BRB	BRB	BRB	BRB	BRB	BRB
9	ATG	ATG	ATG	CAN	ATG	ATG
10	LCA	LCA	LCA	LCA	LCA	LCA
11	BHS	BHS	BHS	DMA	BHS	BHS
12	JAM	JAM	JAM	BHS	JAM	JAM
13	DMA	DMA	DMA	JAM	DMA	DMA
14	DOM	DOM	DOM	DOM	DOM	DOM
15	BLZ	BLZ	BLZ	BLZ	BLZ	BLZ

Ranking of Airlift Availability per Hotel Room

Ranking	Flight	Seats	Passengers	Airlines	Cities	Combined
1	BHS	BHS	BHS	KNA	KNA	BHS
2	BMU	BMU	BMU	BMU	BMU	BMU
3	AIA	AIA	AIA	AIA	CYM	AIA
4	KNA	KNA	KNA	CYM	ABW	KNA
5	CYM	CYM	CYM	ATG	BHS	CYM
6	CAN	CAN	CAN	GRD	AIA	CAN
7	ABW	ABW	ABW	ABW	CAN	ABW
8	DMA	DMA	DMA	DMA	ATG	DMA
9	ATG	ATG	ATG	BHS	GRD	ATG
10	JAM	JAM	JAM	LCA	DMA	JAM
11	BLZ	BLZ	BLZ	BLZ	LCA	BLZ
12	BRB	BRB	BRB	CAN	BLZ	BRB
13	LCA	LCA	LCA	BRB	BRB	LCA
14	GRD	GRD	GRD	JAM	JAM	GRD
15	DOM	DOM	DOM	DOM	DOM	DOM

Source: Air Carrier Financial Reports from United States Department of Transportation; Caribbean Tourism Organization; and authors' calculations.
The combined ranking is a simple average of the rankings for each airlift factor (i.e. Flight, Setas, etc.)

IV. The Data and the Model

A. The Data

The two main sources of data used are the Caribbean Tourism Organization (CTO), which provides monthly tourist arrivals from the U.S. to each Caribbean country in the sample, and Air Carrier Financial Reports (ACFR) from the U.S. Department of Transportation (DOT).[10,11] The ACFR provides monthly records on all air transactions in the U.S.. Data on flights departing from the U.S. to Caribbean destinations are used to study five aspects of airlift supply, namely: (1) the number of flights, (2) number of airlines, (3) U.S. departure cities with non-stop flights,

[10] Tourist arrivals are the most frequently used measure of tourism demand, followed by tourism expenditure (Li *et al*, 2005).

[11] The data comes from forms T-100 International Segment (All Carriers).

(4) number of seats, and (5) the seat vacancy rate. U.S. flights to the Caribbean range from 5-seat private jets to large airplanes with more than 300 seats. Therefore, the total number of seats available is included in the estimations to control for the size of airplanes.[12]

This study takes as a basic microeconomic premise that rational individuals prefer diversity. It follows that increasing the frequency of flights or the number of seats, airlines and departure cities enlarges the options available to potential travelers and may attract more visitors to the Caribbean.

Based on the availability of data on arrivals from the U.S. to the Caribbean, this sample covers monthly data of 14 Caribbean destinations: Antigua and Barbuda, Aruba, Barbados, Belize, Bermuda, Cancun, Cayman Islands, Dominica, Dominican Republic, Grenada, Jamaica, St Kitts and Nevis, St Lucia, and The Bahamas.[13] Since Dickey Fuller tests indicate that the original time series are not stationary, variables have been logged to capture the elasticity and first differenced to filter the time trend.[14]

Table 3. List of Variables and Sources

	Variables	Format	Data Source
Airlift Supply Factors	Number of flights	Logged and FD	Air Carrier Financial Reports, United States Department of Transportation
	Number of airlines	Logged and FD	
	Number of cities	Logged and FD	
	Number of seats	Logged and FD	
	Seat vacancy rate	FD	
Tourism	Tourist arrivals by air from the U.S.	Logged and FD	Caribbean Tourism Organization; and country authorities
Exogenous Demand Control	U.S. unemployment rate	FD	Haver Analytics

Stationarity and Dealing with Stochastic Seasonal Components

In line with other research on tourist arrivals using monthly or quarterly data, we find significant seasonal movements in the series for tourist arrivals, number of flights, number of seats, and the seat vacancy rate.[15,16] The problem of seasonality is often addressed by adding seasonal dummies

[12] It is also possible that larger planes reduce transportation costs and result in lower airfares. Unfortunately, the data from the U.S. DoT does not include information on airfares, an important factor in consumers' tourism decisions.

[13] Anguilla and St. Vincent and the Grenadines were excluded due to data gaps in some of the variables.

[14] DF-GLS unit root tests were performed for each variable and country in the sample. No time trends were found for the first differenced variables.

[15] See Vu and Turner (2006), Song and Witt (2006), Kim and Moosa (2005), and Gustavsson and Nordstrom (2001).

to structural equations. If the seasonal pattern is fixed over time, the difference in levels should be captured by these seasonal dummies. Consequently, monthly dummies were added to the model, but these seasonal dummies turned out not to be significantly different from zero, suggesting the possibility of stochastic seasonality in the data.

Approaches applied in the tourism literature to deal with stochastic seasonality include basic structural models and ARIMA models. The latter has been heavily used in forecasting, but is not suitable for studying causal relationships. This paper uses the basic structural model so that stochastic seasonal components can be filtered out while leaving all other elements intact in order to study the causal relationships with a structural VAR (SVAR). The unobserved component model by Harvey and Todd (1983)—a benchmark model for detecting stochastic seasonal components—is applied.

In the unobserved component model, an observed series can be decomposed into four parts:

$$\text{Observed series} = \text{trend} + \text{seasonal} + \text{cycle} + \text{irregular} \tag{1}$$

The unobserved component model is fit with the monthly seasonal components with no cycles and no trends. In the next step, the deseasonalized series are extracted by subtracting the seasonal component from the original series. See Figure A2 in the Appendix for an example of the unobserved component model and the deseasonalized series.

B. The Model

The SVAR model is used to address endogeneity issues and identify the causal relationship between tourist arrivals and airlift supply factors based on its ability to analyze orthogonalized shocks to the variable of interest by imposing restrictions based on theory. Combining the unobserved component model with the SVAR framework significantly reduces the standard error of the estimates and improves the confidence of the causal relationships estimated. We first employ a panel SVAR approach to assess the dynamic relationships between airlift supply factors and tourist arrivals at the regional level. Country-by-country SVARs are then estimated to explore the possible heterogeneity across destinations.

The empirical model is specified as follows

$$\mathbf{y}_{i,t} = \sum_{j=1}^{k} \boldsymbol{A}_j \mathbf{y}_{i,t-j} + \sum_{j=1}^{m} \boldsymbol{B}_j \mathbf{x}_{i,t-j} + \boldsymbol{\varepsilon}_{i,t} \tag{2}$$

$$\boldsymbol{A}_0 \mathbf{y}_{i,t} = \sum_{j=1}^{k} \boldsymbol{A}_0 \boldsymbol{A}_j \mathbf{y}_{i,t-j} + \sum_{j=1}^{m} \boldsymbol{A}_0 \boldsymbol{B}_j \mathbf{x}_{i,t-j} + \boldsymbol{A}_0 \boldsymbol{e}_{i,t} \tag{3}$$

[16] The autocorrelation function for each destination and for each variable of interest was plotted. Strong seasonality is found in most cases (see Figure A1 in the Appendix for an example of the seasonality found).

$$\mathbf{y}_{i,t} = \begin{pmatrix} \text{Airlines}_{i,t} \\ \text{Cities}_{i,t} \\ \text{Flights}_{i,t}^{DS} \\ \text{Seats}_{i,t}^{DS} \\ \text{US Tourits}_{i,t}^{DS} \end{pmatrix}, \quad \mathbf{x}_{i,t} = \begin{pmatrix} \text{Exogeneous Demand Controls}_{i,t} \\ \text{Natural Disasters}_{i,t} \\ \text{Sept. 11 Attack}_{i,t} \end{pmatrix} \tag{4}$$

where *i* stands for the destination country,
$\mathbf{y}_{i,t}$ contains the vector of endogenous variables (airlift supply factor and tourist arrivals). The superscript contains exogenous variables, including exogenous demand controls such as the U.S. unemployment rate, occurrence of natural disasters, and the September 11 attacks.[18]

The panel SVAR model assumes that the coefficient matrices $\boldsymbol{A_j}$ and $\boldsymbol{B_j}$ are the same for all 14 destinations. The model is estimated by GMM using the code written by Love (2015). Twelve lags were added as suggested by the consistent moment and model selection criteria (MMSC) proposed by Andrews and Lu (2001).[19,20]

In order to identify the causal relationship and back up the structural shocks, restrictions need to be placed on matrix $\boldsymbol{A_0}$. The following assumptions are made to clarify the order of the Cholesky decomposition:

$$\begin{pmatrix} \varepsilon_{i,t}^{\text{Airlines}} \\ \varepsilon_{i,t}^{\text{Cities}} \\ \varepsilon_{i,t}^{\text{Flights}} \\ \varepsilon_{i,t}^{\text{Seats}} \\ \varepsilon_{i,t}^{\text{US Tourists}} \end{pmatrix} = \underbrace{\begin{bmatrix} a_{11} & 0 & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} \end{bmatrix}}_{\boldsymbol{A_0}} \times \begin{pmatrix} e_{i,t}^{\text{Airlines}} \\ e_{i,t}^{\text{Cities}} \\ e_{i,t}^{\text{Flights}} \\ e_{i,t}^{\text{Seats}} \\ e_{i,t}^{\text{US Tourists}} \end{pmatrix} \tag{5}$$

The structure of the SVAR is based on the following train of thought. Tourist arrivals are contemporaneously affected by all airlift supply variables; changes in the number of flights, seats, airlines and departure cities to the Caribbean will have an immediate effect on tourism flows. On the other hand, we assume that changes in tourist arrivals will in turn only affect airlift factors with a lag because quick decisions like changing flight schedules, airplanes, or departure

[17] No significant seasonal effect is found for the number of airlines or cities. As a robustness check, we apply the same filter as other variables with stochastic seasonal components and find no significant change of our results.

[18] We also tested combinations of alternative demand controls, as suggested by Laframboise *et al* (2014), including real GDP growth in the U.S., relative prices between the U.S. and the destination country, and exogenous supply controls such as the price of jet fuel and the price of oil. These variables are found to be insignificant thus were excluded from the model.

[19] The main results do not depend on the number of lags being specified. Models with 4 and 8 lags show consistent results with those presented in the paper.

[20] Their proposed MMSC are similar to maximum likelihood-based model selection criteria for time series models, such as the Akaike information criteria (AIC) and the Bayesian information criteria (BIC).

cities are costly adjustments that airlines will want to minimize in the short term. Therefore, it is assumed that airlines adjust their supply to a destination to changes in demand only with a lag. As a first response, airlines will fill vacant seats or fly with more empty seats to adjust to unexpected changes in demand, rather than changing airplane supply or routes so as to maintain market share and retain customers.

As presented in (5), we assume that airlines' decision-making process in response to changes in demand follows this order: first they adjust the number of seats, i.e., use larger or smaller airplanes as needed on existing routes; second they will adjust the frequency of flights; third they would open or close air routes to the Caribbean; and lastly, the airlines would exit the market or others would enter.[21] Other factors, such as demand determinants (i.e. U.S. unemployment), natural disasters, and the September 11 attacks are considered exogenous to the model and are treated as such.

Additional restrictions on the coefficients of $\boldsymbol{A}_i$ have been placed to improve the accuracy of the estimation in country specific VARs. We assume that tourism flows influence supply variables with a lag of three months, since it takes time for airlines to react to changes in demand. Airlines flying to the Caribbean usually have two schedules per year for the high and low season, and they announce them well in advance.[22,23]

Crucially, the results presented below do not depend on any of the structural assumptions described above. We tested different structures of the order in which the endogenous variables affect each other, and the results are robust to these changes.

V. Main Results

The results of the panel SVAR are presented first, followed by the differences across countries using the individual country SVARs. The third subsection presents the case study of Cuba.

A. A Panel SVAR for the Caribbean

The aggregate dynamics for the Caribbean between tourist arrivals and airlift supply factors employing the panel SVAR approach are presented below. Figure 5 shows that all four airlift

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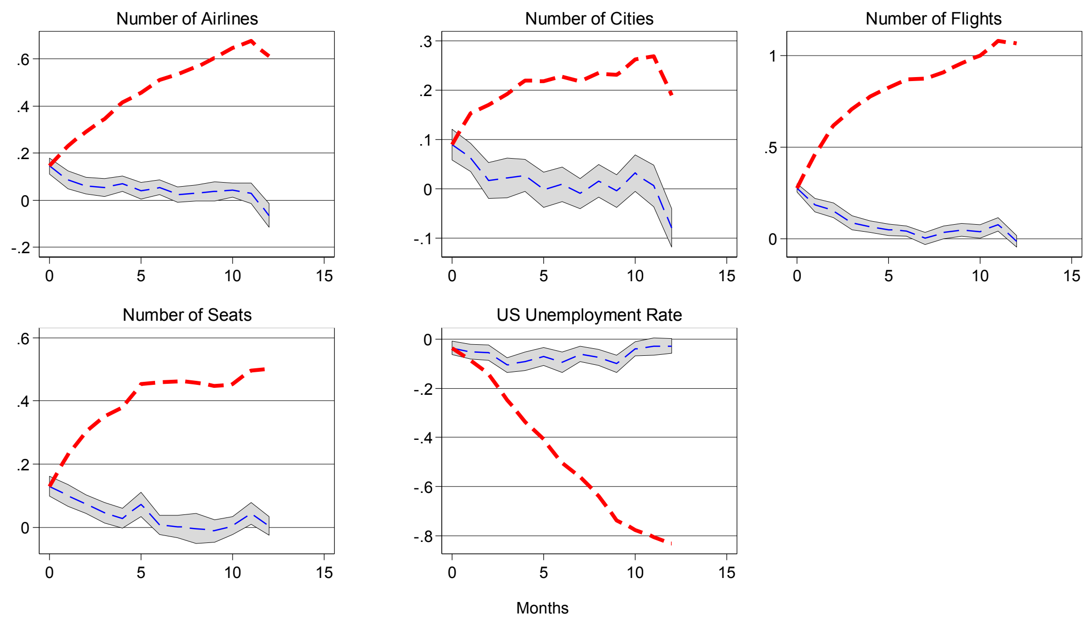
[21] These assumptions translate into the following; the number of airlines affect contemporaneously all other supply factors, while the airlines themselves are only affected with a lag. The numbers of U.S. departure cities with direct flights affects contemporaneously the number of seats and flights, but cities are only affected with a lag by those variables. The number of flights has a contemporaneous effect on the number of seats, and lastly the number of seats is affected contemporaneously by all airlift supply factors, but only has an effect on the other factors with a lag.

[22] December through Easter is usually the high season for most Caribbean countries.

[23] Additionally, in some countries, airlines receive different types of financial incentives to maintain the frequency of flights (minimum seat guarantees, joint marketing with the destination government in source markets, etc) which reduce the incentives for airlines to move their schedules too frequently.

supply factors have a positive and significant impact on tourist arrivals to the Caribbean.[24] The number of flights has the largest impact and seems to be the most effective way to increase arrivals to a country. A 1 percent increase in the number of flights to a destination immediately increases tourist arrivals by 0.3 percent, holding all other variables fixed. The cumulative increase of tourist arrivals is estimated to be around 1 percent after 10 months. As noted earlier, this 1:1 cumulative increase is highly intuitive, but is less obvious when compared with other factors. The supply factor with the smallest impact on tourism is the number of U.S. cities with non-stop flights to the Caribbean.

Figure 5. Response of Tourist Arrivals to Different Shocks (benchmark specification, panel SVAR)



Source: Authors' calculations based on the panel SVAR.
Notes: The blue dashed line represents the percentage deviation from the steady state of the response variable (tourist arrivals) to a one percent positive shock of the impulse variable. The shaded area is the 90% confidence interval and the red dashed line shows the cumulative percentage change of tourist arrivals.

The results show that the U.S. unemployment rate has a very limited impact in the short run but the cumulative impact is large. A 1-percentage point increase in the U.S. unemployment rate reduces tourist arrivals by 0.8 percent in 10 months. This is broadly consistent with the findings of Laframboise *et al* (2014) using panel data analysis.[25]

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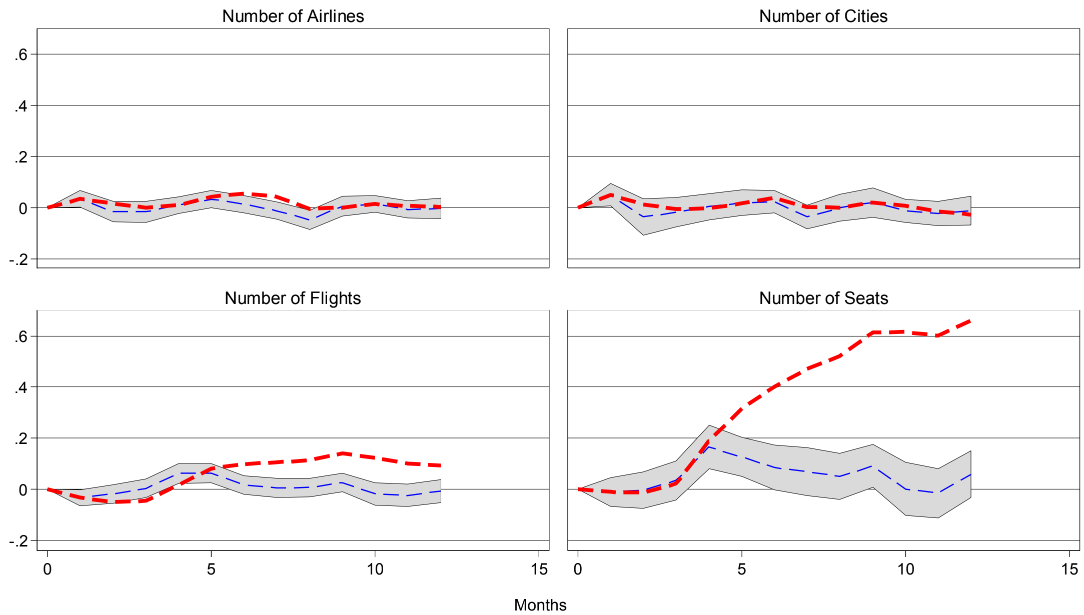
[24] The results are robust to alternative aggregate demand control variables including U.S. household real income, and U.S. real GDP. As a robustness check, the seat vacancy rate was substituted for the total number of seats as an alternative control and the results are consistent with those presented here.

[25] Based on Panel OLS using annual data, Laframboise *et al* (2014) found a 1 percent rise in weighted unemployment rates is associated with about 2 percent decline in tourist arrivals.

Feedback effects from tourist arrivals to airlift supply factors

The feedback effect from tourist arrivals to airlift factors is explored, to see if arrivals in turn drive the supply of airlift. The impact on the number of airlines and the number of markets is almost zero in both the short and medium run (Figure 6). However, the number of flights and the number of seats begin to increase after 4 months, suggesting airlines start to accommodate unexpected demand shocks after 4 to 5 months by scheduling more flights or using bigger aircraft. This is also intuitive and provides an empirical indication of the time lag the industry considers before capacity adjustments.

Figure 6. Response of Airlift Factors to a Tourist Arrivals Shock (benchmark specification, panel SVAR)



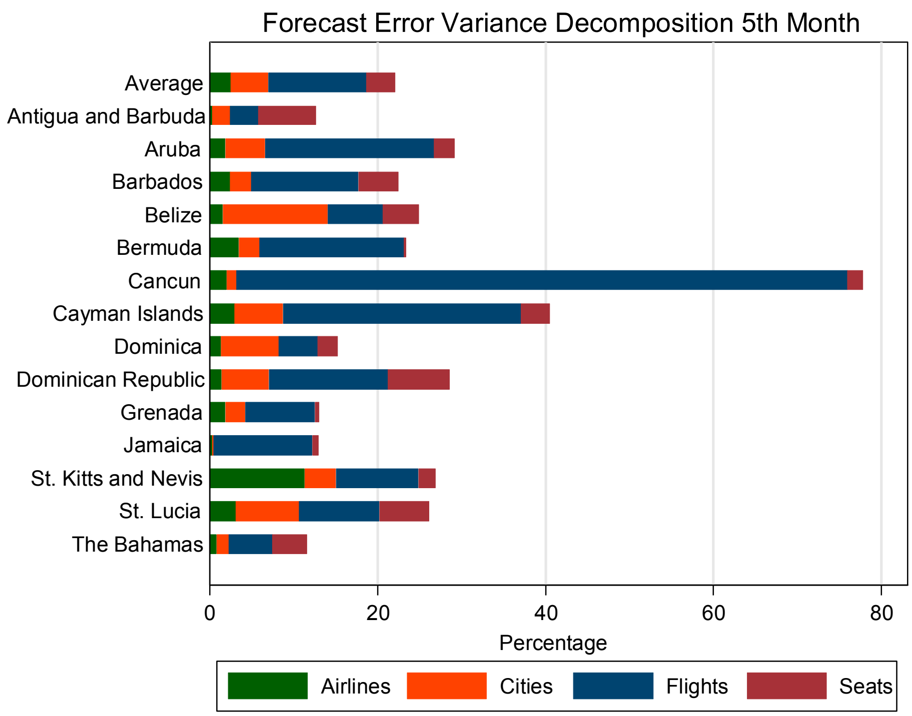
Source: Authors' calculations based on the panel SVAR.
Notes: The blue dashed line represents the percentage deviation from the steady state of the response variable to a one percent positive shock of the impulse variable (tourist arrivals). The shaded area is the 90% confidence interval and the red dashed line shows the cumulative percentage change of the response variable.

B. County-by-County SVARs

Despite the similarities across countries in the Caribbean in terms of natural beauty, tropical beaches, and lovely weather, there are significant differences which merit a more granular study. The type of tourism developed is influenced in large part by country size. In general, larger countries tend to target mass tourism with large hotels and all-inclusive resorts, while smaller countries tend to specialize in small boutique hotels and the upscale market. This subsection examines the heterogeneous dynamics between airlift supply variables and tourist arrivals for individual countries. We investigate the relative importance of each supply factor across destinations by estimating the SVAR model for each destination in the dataset.

From the forecast error decomposition (Figure 7), airlift supply factors explain about 22 percent of the variation in tourist arrivals across countries, with the number of flights explaining on average 11.7 percent.[26] This result is consistent with the previous panel SVAR, where more flights was the best way to increase the flow of tourists to the Caribbean. With the exception of three countries, the Caribbean would benefit more from increasing the frequency of flights than from increasing any other airlift supply factor.[27] The exceptions are Antigua and Barbuda, which would benefit more from more seats (bigger planes); Belize, which needs direct flights from more U.S. cities, and St. Kitts and Nevis, whose tourism industry would gain from more airlines connecting the country to the U.S.

Figure 7. The Relative Importance of Shocks on Tourist Arrivals



Source: Authors' calculations based on country specific SVARs.
Note: The variance decomposition indicates the amount of information each variable contributes to the other variables in the auto regression. Average statistics is calculated after dropping Cancun.

Table 4 presents the impact on tourist arrivals of each of the supply factors in the columns and the significance of the response. The darker green color indicates that the response of arrivals

[26] Airlines explain on average 2.5 percent of the variation in tourist arrivals, departure cities 4.4 percent, flights 11.7 percent, and seats 3.5 percent.

[27] Dominica is also one of the countries where departure cities appear to have a bigger effect on tourism (Figure 7), but as is shown in Table 4, the impact is negative and insignificant, and the country would benefit mostly from increasing the frequency of flights from the U.S.

was significantly different from zero for more than four periods. The left panel of Table 4 shows the immediate impact of a 1 percent increase in each airlift factor, while the right panel presents the cumulative impact after 5 months. The number of flights is again the most important factor influencing tourism flows for most countries: it is not only the variable with the largest impact, as noted above, but is also the one with the most persistently significant effect on tourism. The other three factors are significantly important for the tourism industry only in some destinations. For instance, increasing the number of airlines has a significant impact on tourist arrivals for St. Kitts and Nevis, but in most other countries (with the exception of Bermuda and Cayman Islands), the positive impact is not statistically significant.

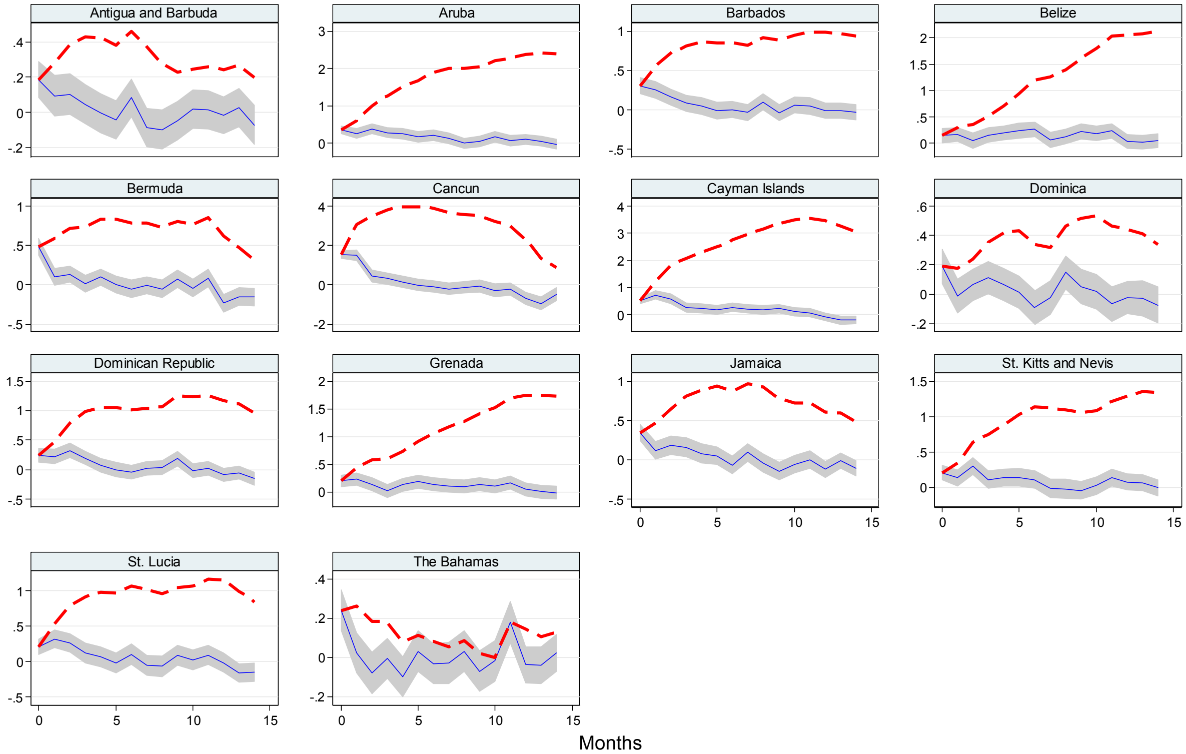
Table 4. Heterogeneity in the Response of Tourist Arrivals Across Counties

	Immediate impact of a 1% shock to				Cumulative impact (5th month) of a 1% shock to			
	Airlines	Cities	Flights	Seats	Airlines	Cities	Flights	Seats
Average	**0.11**	**0.11**	**0.37**	**0.13**	**0.27**	**0.29**	**1.19**	**0.51**
Antigua and Barbuda	0.02	0.12	0.19	0.23	0.05	(0.12)	0.38	0.51
Aruba	(0.04)	0.21	0.35	0.18	0.17	0.90	1.68	0.54
Bahamas, The	0.08	(0.04)	0.24	0.21	0.09	(0.30)	0.11	0.47
Barbados	0.17	0.12	0.31	0.17	0.00	0.57	0.85	0.60
Belize	0.06	0.31	0.14	0.07	0.29	1.13	0.94	0.31
Bermuda	0.12	0.17	0.48	0.02	0.51	0.27	0.84	(0.09)
Cancun	0.33	0.19	1.55	(0.03)	0.21	0.31	3.97	0.59
Cayman Islands	0.30	0.10	0.52	0.21	0.73	(1.07)	2.49	1.01
Dominica	0.02	(0.17)	0.19	0.12	0.21	(0.08)	0.43	0.46
Dominican Republic	0.09	0.10	0.25	0.14	(0.13)	0.58	1.06	1.10
Grenada	0.06	0.03	0.20	(0.00)	0.40	0.33	0.92	0.17
Jamaica	(0.04)	0.01	0.34	0.05	(0.11)	0.02	0.94	0.28
St Kitts and Nevis	0.34	0.17	0.21	0.16	0.97	0.50	1.03	0.36
St Lucia	0.06	0.19	0.21	0.29	0.45	1.07	0.97	0.80

Source: Author's calculations based on country specific SVARs.
Notes: The first four columns show the immediate response of tourist arrivals to a shock in the four airlift supply variables. The number in the cells indicates the immediate percent change in tourist arrivals after the shock. The green color indicates the significance. The dark green color indicate the response is different from zero for more than 4 periods; the lighter green for more than 2 periods.

Seats and departure cities are tied in importance after flights in terms of significance; both count six countries with a significant response. However, in terms of the magnitude of the impact, the results suggest that it would be better to increase the number of seats than departure cities since a 1 percent increase in seats would result in an average increase in tourists of 0.5 percent after five months. Increasing departure cities by 1 percent would only increase arrivals by 0.3 percent over the same period. The least important airlift factor is the number of airlines: it has the lowest impact on tourist arrivals and it is also the one with the lowest significance across countries. While the dynamics and the pattern of the response differ across countries, the number of flights consistently improves tourism flows for all countries. The impulse responses of tourist arrivals to an increase in the numbers of flights are presented in Figure 8.

Figure 8. Response of Tourist Arrivals to a 1% Shock in the Number of Flights (benchmark specification, country SVARs)



Source: Authors' calculations based on country specific SVARs.
Notes: Impulse: the number of flights. The shaded area is the 90% confidence interval and the red dashed line gives the cumulative percentage change.

After observing the heterogeneity in responses to different airlift factors across countries, patterns between the airlift supply statistics and the response across countries are investigated. Table 5 shows the significance of the responses presented in Table 4 (colored cells) over the average values of each variable across countries. The table shows that the differences across countries cannot be simply explained by the historic condition of airlift supply, that is, it is not the case that countries with few airlines or departure cities have the most significant responses to those variables, or vice versa. Grenada, for example, has been serviced on average by two airlines and has direct flights from only two U.S. cities, but the impact of adding airlines is small and insignificant.[28]

The heterogeneity in responses is likely linked to destination specific characteristics. Additional aspects are considered (last three columns of Table 5), including the number of tourist arrivals, the vacancy rate, and the ratio of tourist arrivals to the number of passengers.[29] In most cases, these country characteristics cannot explain the differences in responses either. The exception is

[28] This is still the case even after controlling for the size of the country (land area).

[29] The distance between the destination and the U.S. was also checked, but did not offer any additional insight.

in Dominica, where most of the airlift supply factors have an insignificant effect on tourist arrivals, which could be explained by the high U.S. tourist-to-passenger ratio. A portion of U.S. tourists visiting Dominica (at least 16 percent) arrive in the country indirectly through connections in other Caribbean airports, so it is likely that regional airlift is a more important determinant of Dominica's tourist arrivals than U.S. airlift.

Table 5. Average Airlift Supply (1990-2014) and Significance of Tourist Arrivals Response to Different Airlift Supply Factors

	Average 1990-2014				Tourist	Vacancy	Arrivals /
	Airlines	Cities	Flights	Seats	Arrivals	Rate	Passengers
Antigua and Barbuda	5	4	130	16,420	6,140	37%	62%
Aruba	10	11	327	57,190	36,540	28%	89%
The Bahamas	17	21	1,800	147,590	100,110	35%	109%
Barbados	5	5	175	29,366	10,128	33%	53%
Belize	4	4	168	23,745	12,112	38%	72%
Bermuda	6	8	282	47,264	20,441	36%	63%
Cancun	20	33	1,409	229,250	129,677	27%	68%
Cayman Islands	7	9	299	40,653	20,040	35%	76%
Dominica	1	1	37	2,148	1,440	38%	116%
Dominican Republic	16	14	1,303	198,181	78,087	32%	48%
Grenada	2	2	42	4,861	2,360	39%	88%
Jamaica	12	16	868	152,908	78,984	31%	74%
St Kitts and Nevis	4	5	122	8,597	4,056	40%	81%
St Lucia	5	5	120	12,695	7,796	32%	91%

Source: Authors' calculations based on country specific SVARs.
Notes: The numbers in each cell represent the monthly average statistics for airlift supply variables. The green color indicates the significance of the tourist arrivals response after each airlift supply shock. The dark green color indicates the response is different from zero for more than 4 periods; the lighter green for more than 2 periods.

Table 6 summarizes the interactions across all airlift supply variables and tourist arrivals.[30] Cells are marked dark green if 8 or more countries out of the 14 destinations have positive responses to the different shocks, and light green if between 2 and 7 countries have a significant response. Red cells and pink cells represent negative responses for a large and a small number of countries, respectively. The top panel shows the responses in the short-run (1 to 3 months), while the bottom panel shows the responses over the medium-term (3 to 14 months).

[30] For country by country impulse response functions, please see Figure A6 in the Appendix.

Table 6. Significance of Responses Across Countries (benchmark specification)

		Shocks							
		Unemp. Rate	Airlines	Cities	Flights	Seats	Tourist Arrivals	Natural Disasters	Sept. 11 Attacks
Short Run OIRFs (1 to 3 months)									
Responses	Unemp. Rate		0	0	0	0	0	.	.
	Airlines	.		0	0	0	0	.	.
	Cities	.	.		0	0	0	.	.
	Flights	.	.	.		0	0	.	.
	Seats	.	.	.	.		0	.	.
	Tourist Arrivals	.	.	.	.	.		.	.
Long Run Cumulative OIRFs (3 to 14 months)									
Responses	Unemp. Rate		.	.	.	.	.	.	.
	Airlines	.		.	.	.	.	.	.
	Cities	.	.		.	.	.	.	.
	Flights	.	.	.		.	.	.	.
	Seats	.	.	.	.		.	.	.
	Tourist Arrivals	.	.	.	.	.		.	.

Source: Authors' calculations based on country specific SVARs.
Notes: The zeros indicate the constaints imposed. The panels show the significance of the response (rows) to different shocks (columns), across countries. The intensity of the color indicates the significance of the response after each shock. The dark colors indicates the responses were different from zero for more than 8 countries (out of 14 countries); the lighter colors indicate the responses were different from zero for more than 2 countries. The green color shows positive responses, and the red negative ones.

Table 6 shows that a change in the number of airlines has a limited impact on tourist arrivals for most countries. However, adding more airlines results in an expansion in the number of cities and flights, which could be an indirect way of increasing tourist arrivals. However, this connection appears to be short lived as the number of countries with a significant response decreases over the medium-term. Interestingly, an increase in the number of departure cities does not appear to increase the number of flights. This suggests that opening routes from new U.S. departure cities, does not increase the overall frequency of flights to a destination as airlines instead shift flights from established routes to new ones, leaving the total number of flights unchanged. This is consistent with results from the panel SVAR (Figure 20 in the Appendix). Having more flights brings more tourists to the destination both in the short run and medium run. In addition, the number of available seats is positively affected by the number flights, as expected. Also in line with our panel SVAR estimation, tourist arrivals are only affected by the U.S. unemployment rate over the medium-term.[31]

Controlling for Exogenous Shocks

The Caribbean is a region susceptible to external shocks, particularly natural disasters. It is therefore important to control for the effects of these shocks when studying the tourism sector. The estimations also control for the negative effects that the 2001 September 11 attacks had on the U.S. travel industry and Caribbean tourism.

Natural Disaster Shocks

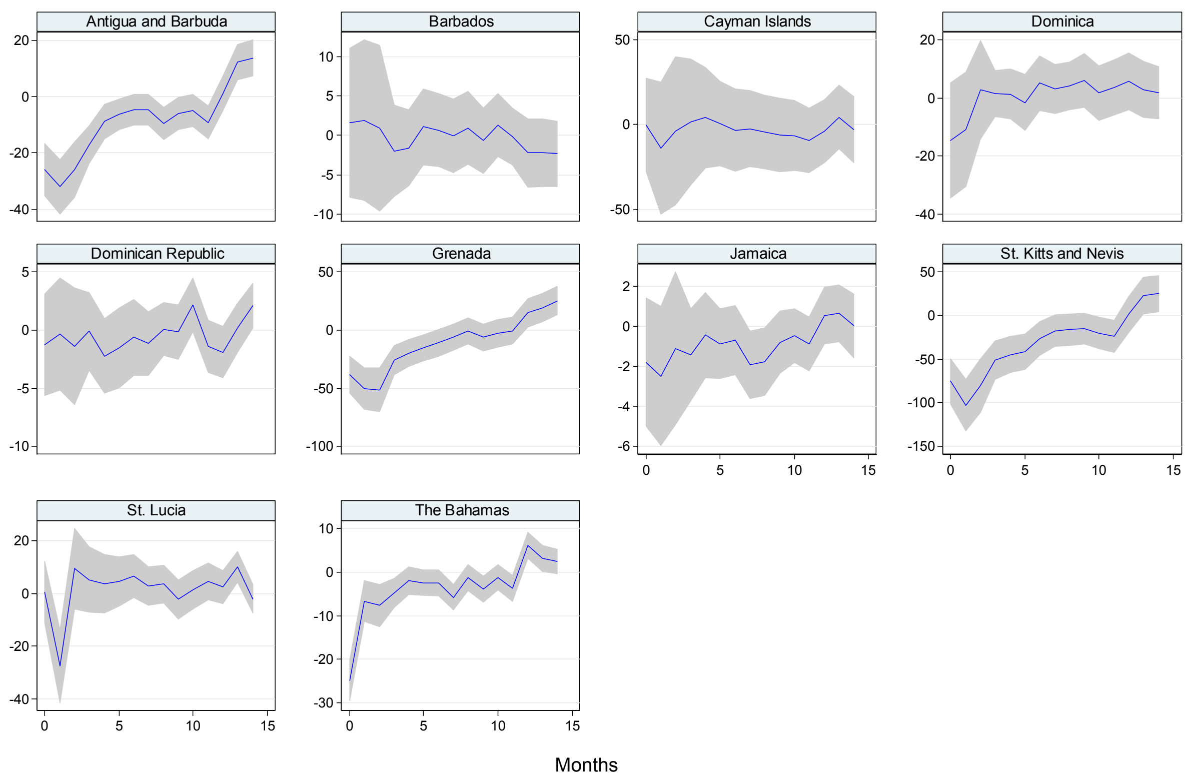
Using data from the International Disaster Database (EM-DAT), a dummy variable of natural disasters caused by storms is created. The number of people affected by the storm is used to

[31] The heterogeneity in the impulse response functions in reaction to the unemployment rate shock also reveals different demand elasticities of U.S. tourist arrivals across Caribbean countries.

distinguish between moderate and severe disasters, following Acevedo (2014).[32] The monthly dummy variables of natural disasters for the 14 Caribbean destinations in the sample are constructed. Storms are considered 'moderate' if more than 0.01 percent of the population is directly affected, while storms are considered 'severe' when 1 percent or more of the population is affected.

Figure 9 presents the responses of tourist arrivals to the natural disaster shock. Countries have different responses depending on the severity of the disasters usually experienced. In countries with more frequent severe disasters, such as Antigua and Barbuda, the Bahamas, Grenada and St. Kitts and Nevis, there is a large decrease in tourists *ex post*. The immediate drop in visitors ranges from 30 to 50 percent, and on average the total decline in arrivals over one year exceeds 90 percent after a large disaster. The sector usually starts to grow again 10-12 months after the disaster. On the other hand, small disasters do not seem to have a significant impact on arrivals. This is the case for Barbados, Cayman Islands, Dominica, Dominican Republic, and Jamaica, which tend to experience moderate disasters.

Figure 9. Response of Tourist Arrivals to a Natural Disaster Shock



Source: Authors' calculations based on country specific VARs.
Notes: Impulse: dummy variable for natural disasters. The shaded area is the 90% confidence interval.

[32] Storms (i.e. tropical cyclones) are the most prevalent type of disaster in the Caribbean.

There is some evidence that, when a natural disaster strikes only in one Caribbean destination, there is a corresponding reallocation of tourists (see Figure A7 in the Appendix). This effect appears to benefit only a handful of countries (Antigua and Barbuda, Dominica, and the Dominican Republic), where tourist arrivals increase following a natural disaster shock in another country (but not in theirs). For most islands a natural disaster in another Caribbean destination has no impact on how many tourists they attract.

September 11 Attacks

After the September 11 attacks, airline travel to the Caribbean fell by 30 percent. This decline was associated with a drop in the number of seats and the number of flights to many destinations, although the pattern varied across countries. Islands close to the U.S. eastern seaboard, such as Bahamas, Bermuda and Cayman Islands, suffered greatly from the 9/11 attacks, while Dominica and St. Kitts seemed to be less affected (see Figure A6 in the Appendix).

Robustness of the Results

As noted earlier, robustness checks were performed to make sure that the results were not dependent on the structural assumptions. The results are found to be robust to different ordering assumptions of the endogenous variables. Additionally, alternative specifications were estimated that included different price variables such as relative prices between the U.S. and the destination country, jet fuel and oil prices. These relative prices give an indication about price sensitivity of U.S. tourists, while jet fuel and oil prices were intended as a proxy for airfare prices. However, none of these measures has a significant impact on tourist arrivals. Interestingly, the estimations find that a shock to jet fuel prices has no impact on airlift supply factors.[33] The rest of the results hold even after introducing these price variables into the estimations.[34]

Additionally, as noted previously, different demand controls were included in the estimations. They included a measure of U.S. household real income, and U.S. real GDP growth; however, these demand controls were not statistically significant for most countries, while U.S. unemployment was significant in most of the estimations. The introduction of alternative demand controls is consistent with the results presented in the paper as the effects of airlift on tourism was not dependent on the demand variables used.

C. Case Study: Cuba

In this subsection, the potential impact of further opening of U.S.-Cuba travel on the rest of the Caribbean tourism industry is explored. Cuba does not publish monthly tourist arrivals from the U.S., so it is not possible to directly estimate the impact of rising U.S. arrivals to Cuba on other Caribbean destinations. However, there is good data on U.S.-Cuba flights, so the possible

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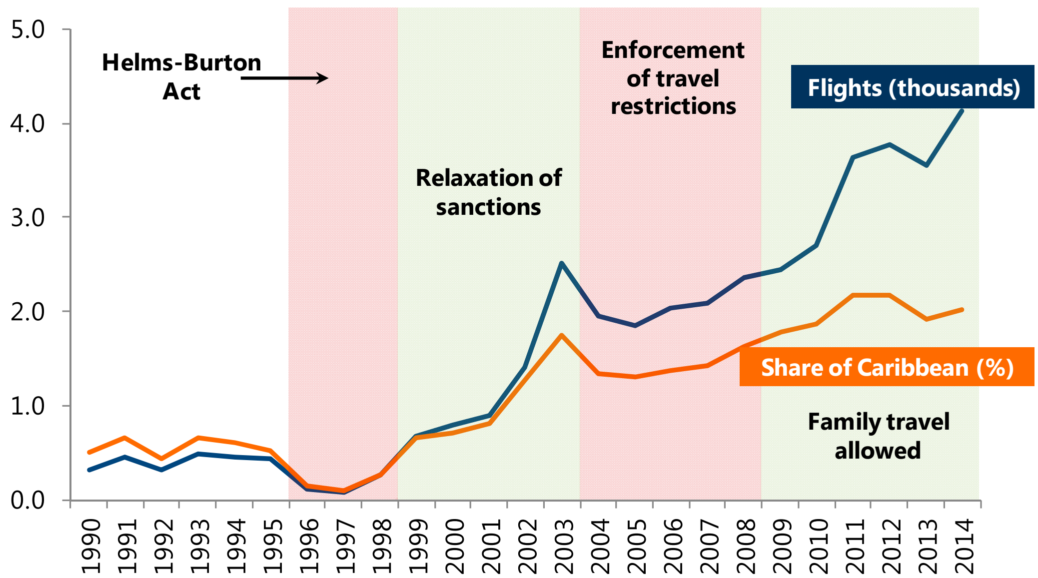
[33] This might be due to two reasons: 1) airlines hedge against oil prices shocks and therefore their supply does fluctuate with oil prices, and 2) flights are scheduled and booked several months in advance, therefore by the time of fuel price changes, airlines cannot adjust the number of flights.

[34] Some of the robustness results are presented in Figures A3 and A4 in the Appendix; the rest are available upon request.

crowding out effect on flights to other Caribbean countries is investigated as restrictions on U.S. travel to Cuba are relaxed.

Figure 10. Direct Flight From the U.S. to Cuba



Sources Bureau of Transportation Statistics; and authors' calculations.

Figure 10 illustrates why the proposed estimation is relevant, even with historical data that reflects a heavily regulated travel environment between these two countries. The number of flights between the U.S. and Cuba are plotted against a background of periods when U.S.-Cuba travel restrictions were enforced more vigorously (pink), and periods when those restrictions were relaxed (light green). The chart demonstrates the adverse impact of the U.S. restrictions, but more importantly it also shows that in recent history there have been rapid changes in the supply and demand for flights between the U.S. and Cuba that depend on the enforcement of restrictions, not surprisingly. Therefore, we can estimate the impact in other Caribbean destinations of the changes in the number of U.S.-Cuba flights.[35]

The impact on U.S. flights to each destination from an increase in U.S.-Cuba flights is thus estimated for both the panel SVAR and the country-by-country SVARs, with structural restrictions as in (6).[36]

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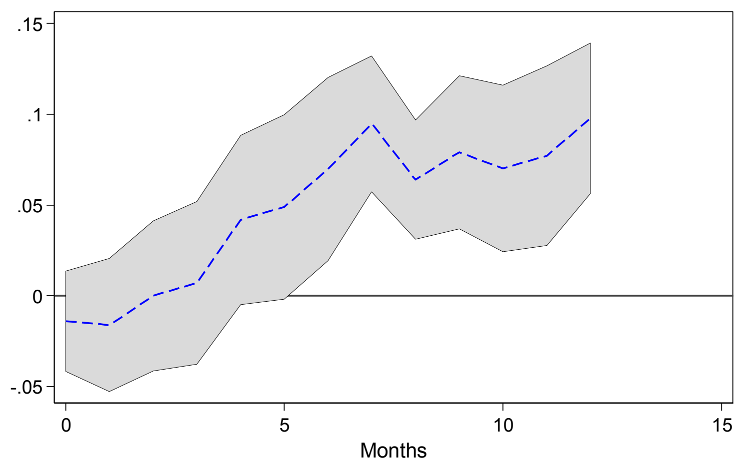
[35] Figure 10 shows that there is already a large number of flights between the U.S. and Cuba. In 2014, they surpassed 4,000 flights per year (more than what each of the smaller islands receives, with the exception of Aruba). In 2014, Cuba received more than 370,000 passengers flying from the U.S.

[36] Different specifications were estimated with the number of airlines and number of departure cities to the destination not being affected by the number of flights to Cuba, and the results are robust. The number of flights to all other Caribbean countries is also included as a control variable.

$$\begin{pmatrix} \varepsilon_{i,t}^{Flights\ to\ Cuba} \\ \varepsilon_{i,t}^{Airlines} \\ \varepsilon_{i,t}^{Cities} \\ \varepsilon_{i,t}^{Flights} \\ \varepsilon_{i,t}^{US\ Tourists} \end{pmatrix} = \begin{bmatrix} a_{11} & 0 & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} \end{bmatrix} \times \begin{pmatrix} e_{i,t}^{Flights\ to\ Cuba} \\ e_{i,t}^{Airlines} \\ e_{i,t}^{Cities} \\ e_{i,t}^{Flights} \\ e_{i,t}^{US\ Tourists} \end{pmatrix} \quad (6)$$

The panel SVAR results show that an increase in U.S.-Cuba flights does not reduce the availability of flights to other Caribbean destinations. On the contrary, flights to the Caribbean gradually increase 5 to 6 months after a 1 percent increase in flights to Cuba. The average increase for all countries in the sample is around 0.1 percent after one year. Instead of a crowding out effect, based on past observations, the expanding supply of flights to Cuba appears to promote more flights to other Caribbean countries (Figure 11).

Figure 11. Response of Flights to an Increase in Flights to Cuba Shock

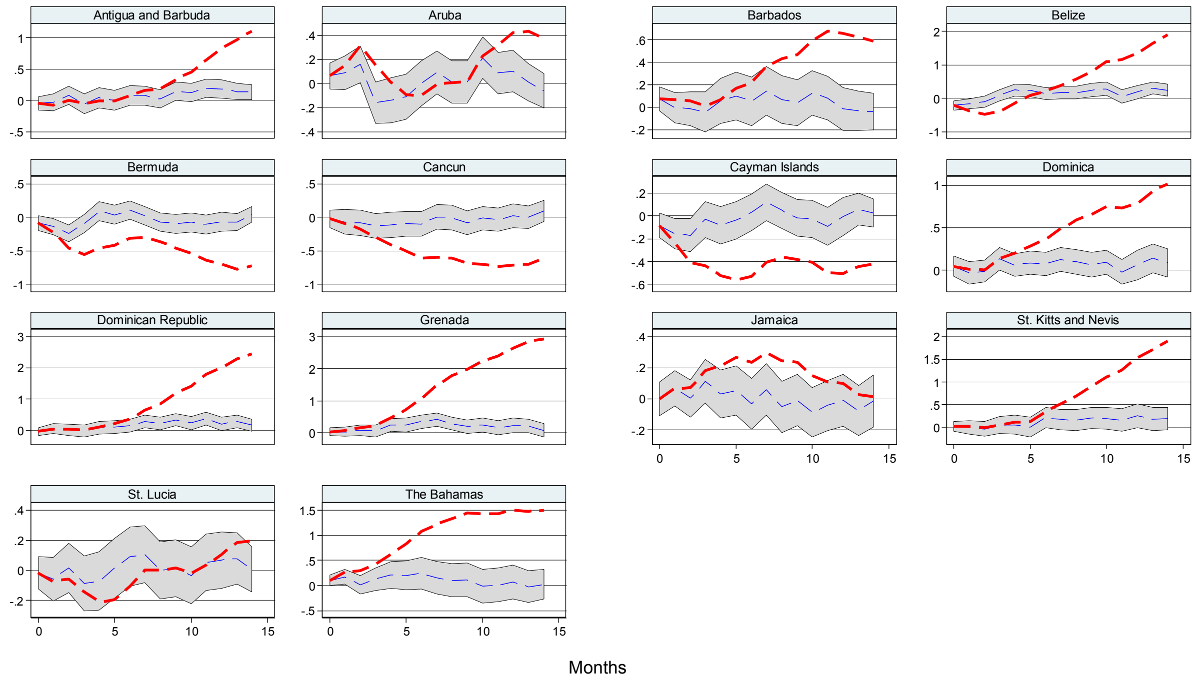


Source: Authors' calculations based on the panel VAR.
Notes: Impulse: the number of flights to Cuba. The shaded area is the 90% confidence interval.

Figure 12 highlights the response of flights to each country to the shock of more flights to Cuba. The immediate response is almost zero for all, and only briefly statistically significant in the case of Belize. Although the cumulative responses vary among countries, they are not statistically significant.

In the estimation for the panel and individual country SVARs, the study also controls for flights to the rest of the Caribbean and finds that an increase in flights to the rest of the Caribbean has no negative impact on flights to each individual destination. Given these results, it is not surprising there is no negative impact observed on the rest of the Caribbean arising from increasing the number of flights to Cuba. Both results suggest that there is no substitution of flights within the Caribbean, i.e., it is not a zero sum game where one destination's gain is another's loss. There are several possible explanations of how this might happen: the airline industry expands their fleet in order to increase the number of flights to a Caribbean destination; they shift flights from other regions (domestic, Latin America); or they accommodate greater demand by scheduling more flights without requiring an increase in the fleet.

Figure 12. Response of Flights to an Increase in Flights to Cuba Shock



Source: Authors' calculations based on country specific VARs.
Notes: Impulse: the number of flights to Cuba. The shaded area is the 90% confidence interval and the red dashed line shows the cumulative percentage change.

These results need to be interpreted carefully. At both the aggregate level and for each individual country, flights to Caribbean destinations are not negatively affected by an increase in U.S.-based flights to Cuba. However, the changes in U.S.-Cuba flights over the past 25 years might be too small in comparison to what could ensue with a full opening of U.S. travel to Cuba. A change of that magnitude over the short run might require U.S. airlines to shift flights from other destinations to accommodate a sharp increase in demand.[37] However, airlines might decide to shift flights from domestic routes or from Central or South America, and not just from the Caribbean. Additionally, servicing Cuba from Miami will require fewer airplanes than servicing other Caribbean destinations given the proximity between Havana and Miami. Nonetheless, the results suggest that Caribbean nations should not fear an orderly and gradual relaxation of travel restrictions to Cuba.

[37] Airlines order aircrafts well in advance and cannot increase their fleet suddenly by purchasing from manufacturers. However, if the change is gradual, this might not be a problem.

Robustness of the Results

The hypothesis presented, that there is no crowding out effect on flights to other Caribbean countries, remains valid when shocking U.S. flights to other non-Cuba destinations, such as the Dominican Republic. In many ways, the Dominican Republic is similar to Cuba: both are Spanish speaking and are relatively big islands where tourism is one of the main industries. Based on the same panel SVAR model, the estimates show that a positive shock to the number of flights from the U.S. to the Dominican Republic has a statistically significant positive spillover on the number of flights to other countries in the region. The result shows that the immediate response is larger than comparable results for Cuba, with a 1 percent increase in the number of U.S.– Dominican Republic flights associated with an immediate increase of 0.1- 0.15 percent in the number of flights to other countries in the region (see Figure A8 in the Appendix).

VI. Conclusions and Policy Implications

This paper studies the role that airlift supply factors play on tourist arrivals in the Caribbean. The impact of the number of flights, seats, airlines and U.S. departure cities with non-stop flights on tourist arrivals to 14 Caribbean destinations is examined. A panel and individual countries structural VARs are estimated where the issue of endogeneity—the feedback effect that tourist arrivals in turn have on airlift supply factors—is addressed. Under different structural specifications, the results are found to be robust and do not depend on the preferred specification.

While it is no surprise that more flights, seats, airlines, and departure cities have an important and positive impact on tourism flows; this is the first paper, to our knowledge, that seeks to compare the relative importance of each factor while addressing the endogeneity between arrivals and airlift supply. The estimations find consistently across the different methods and specifications that 'the number of flights' is the most important airlift supply factor determining tourist arrivals. The number of flights is found to have the largest impact on tourist arrivals, 0.3 percent on impact and 1 percent after 10 months, but is also the factor with the most persistent significant effects over time and across countries.[38]

These findings suggest that tourism authorities across the Caribbean should focus their efforts on improving airlift by seeking to increase the number of flights. While all the other factors show a positive impact on tourism flows, it is the number of flights that is more likely to result in more tourists coming to their shores. This does not suggest limiting destinations to only one airline with frequent flights. Variety and diversification are also important and our results support that. However, given the choice to negotiate with an existing airline to increase the frequency of flights, or with a new airline to initiate flights to the islands, our results suggest that countries will be better off adding one more flight from an existing airline. This finding is particularly relevant since many Caribbean nations, particularly the smaller ones, provide subsidies or incentives of some kind to entice airlines to their island. Without jeopardizing market concentration, governments may find fiscal savings by negotiating with a smaller pool of airlines

[38] One caveat: the results hold under the assumption that destinations have well developed tourism sectors that attract tourists. Increasing the number of flights by itself will not help a destination without a viable product.

with more frequent flights than by seeking to increase the number of airlines and direct connections.

The paper also estimates the impact of expanding flights from the U.S. to Cuba on the rest of the Caribbean. Changes in the number of U.S.-Cuba flights over the last 25 years have been large, reflecting changing U.S. travel policies to Cuba. The paper finds that, based on past experience, there has been no negative effect from expanded flights to Cuba on the number of flights to the rest of the Caribbean. However, given the change in magnitude likely under a full U.S.-Cuba opening, caution is warranted as these results might not hold under such a scenario. Nonetheless, in a scenario of gradual and orderly opening, the Caribbean should not fear losing flights after U.S. travel to Cuba is liberalized.

VII. References

Acevedo, Sebastian, 2014, “Debt, Growth and Natural Disasters: A Caribbean Trilogy”, IMF Working Paper 14/125.

Andrews, Donald WK, and Biao Lu. 2001, "Consistent model and moment selection procedures for GMM estimation with application to dynamic panel data models."*Journal of Econometrics* 101, no. 1 pp.123-164.

Athiyaman, A.,1997, “Knowledge development in tourism: tourism demand research”, *Tourism Management*, Vol. 18, pp. 221-228.

Crouch, G., 1994, “The Study of International Tourism Demand: A Survey of Practice,” *Journal of Travel Research*, Vol. 33, pp. 41-55.

Culiuc, Alexander, 2014, “Determinants of International Tourism,” IMF Working Paper No. 14/82.

Harvey, Andrew C., and P. H. J. Todd. 1983, "Forecasting economic time series with structural and Box-Jenkins models: A case study." *Journal of Business & Economic Statistics* 1, no. 4 pp.299-307.

Gustavsson, Patrik, and Jonas Nordström. "The impact of seasonal unit roots and vector ARMA modelling on forecasting monthly tourism flows." *Tourism Economics* 7, no. 2 (2001): 117-133.

Kim, Jae H., and Imad A. Moosa. 2005, "Forecasting international tourist flows to Australia: A comparison between the direct and indirect methods." *Tourism Management* 26, no. 1 pp. 69-78.

Laframboise, Nicole, Nkunde Mwase, Joonkyu Park, and Yingke Zhou. 2014,“Revisiting Tourism Flows to the Caribbean: What is Driving Arrivals?”. IMF Working Paper 14/229.

Li, Gong, H. Song, and SF Witt., 2005 “Recent developments in econometric modelling and forecasting” *Journal of Travel Research* 44 (1), pp.82-99.

Mwase, Nkunde, 2013, “Tourism flows to Caribbean islands: an empirical note,” Applied Economics Letters, Volume 20, Issue 10, pp. 957-965.

Love, Innessa, 2015, “PVAR: Package of programs to estimate panel VAR”. Available: https://sites.google.com/a/hawaii.edu/inessalove/home/pvar

Song, Haiyan, and Stephen F. Witt., 2006 "Forecasting international tourist flows to Macau." *Tourism management* 27, no. 2 pp. 214-224.

Tsounta, Evridiki, 2008, “What Attracts Tourists to Paradise?” IMF Working Paper No. 08/162.

Vu, Jo Chau, and Lindsay W. Turner.2006, "Regional data forecasting accuracy: the case of Thailand." *Journal of Travel Research* 45, no. 2 pp. 186-193.

Wolfe, Andy and Rafael Romeu, 2011, “Recession and Policy Transmission to Latin American Tourism: Does Expanded Travel to Cuba Offset Crisis Spillovers?” IMF Working Paper No. 11/32.

Witt, Stephen F., and Christine A.Witt. 1992, “Modeling and forecasting demand in tourism”, *International Journal of Forecasting*, Vol. 8, pp. 643-644.

Zhang, Xinyan, Haiyan Song, and George Q. Huang. 2009,"Tourism supply chain management: A new research agenda." *Tourism management* 30, no. 3 pp.345-358.

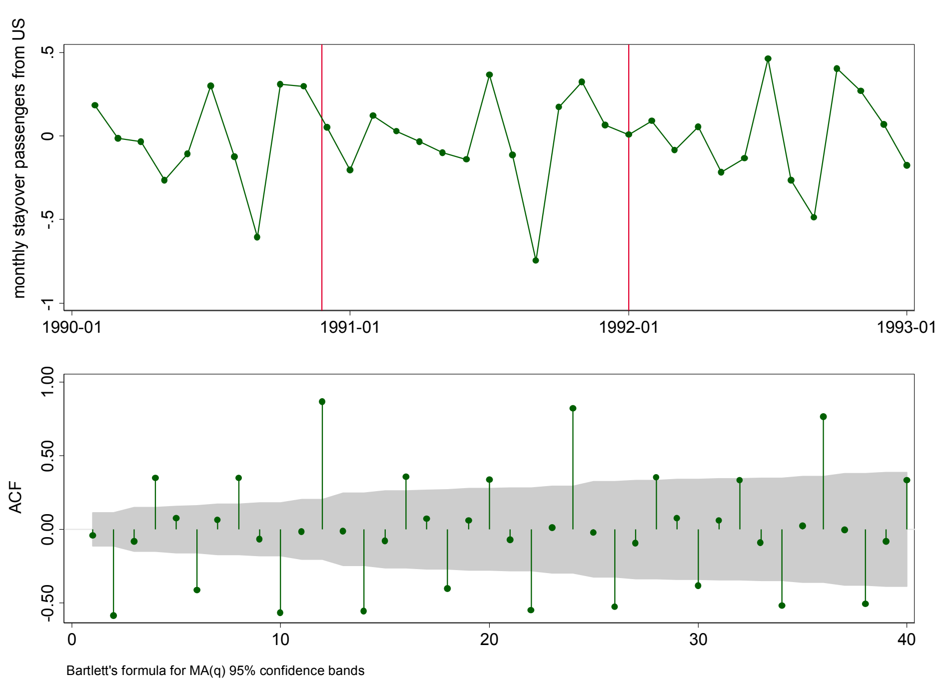
VIII. APPENDIX

Table A1. Coefficient of Variation (1990-2014) and Significance of Tourist Arrivals Response to Different Airlift Supply Factors

	Airlines	Cities	Flights	Seats	Tourist Arrivals	Vacancy Rate	Arrivals / Passengers
Antigua and Barbuda	0.30	0.26	0.27	0.32	0.33	0.33	0.27
Aruba	0.25	0.29	0.18	0.16	0.26	0.37	0.11
Barbados	0.30	0.30	0.23	0.23	0.23	0.35	0.19
Belize	0.24	0.32	0.22	0.24	0.38	0.27	0.14
Bermuda	0.24	0.29	0.30	0.33	0.53	0.24	0.23
Cancun	0.24	0.16	0.34	0.33	0.26	0.39	0.23
Cayman Islands	0.26	0.27	0.21	0.22	0.32	0.25	0.29
Dominica	0.22	0.09	0.28	0.30	0.29	0.26	0.35
Dominican Republic	0.30	0.46	0.35	0.32	0.53	0.35	0.22
Grenada	0.45	0.40	0.38	0.31	0.33	0.34	0.40
Jamaica	0.19	0.21	0.21	0.18	0.34	0.34	0.14
St Kitts and Nevis	0.52	0.58	0.34	0.38	0.45	0.23	0.35
St Lucia	0.29	0.37	0.34	0.30	0.35	0.32	0.22
The Bahamas	0.28	0.21	0.56	0.26	0.27	0.25	0.33

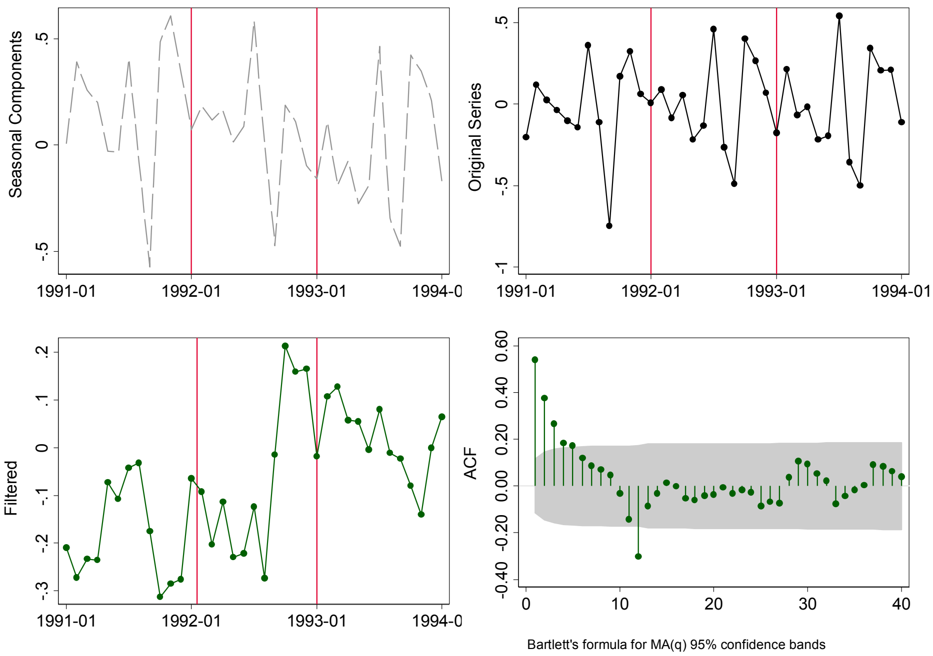
Source: Authors' calculations based on country specific SVARs.
Notes: The numbers in each cell represent the coeficient of variation (standard deviation over mean) statistics for airlift supply variables. The green color indicates the significance of the tourist arrivals response after each airlift supply shock. The dark green color indicates the response is different from zero for more than 4 periods; the lighter green for more than 2 periods.

Figure A1. Stochastic Seasonality



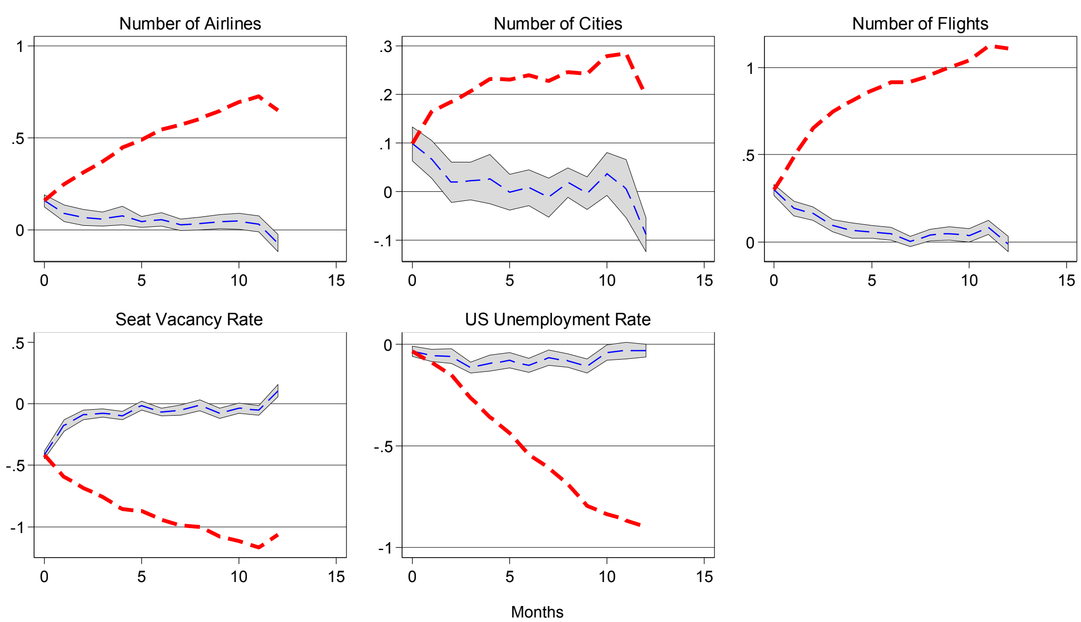
Note: The upper figure presents the percentage change of tourist arrivals for Barbados from 1990 to 1993. The bottom figure gives the autocorrelation function of the series. The high correlation with its 12th, 24th and 36th lags indicates a strong seasonality in the series.

Figure A2. Unobserved Component Model



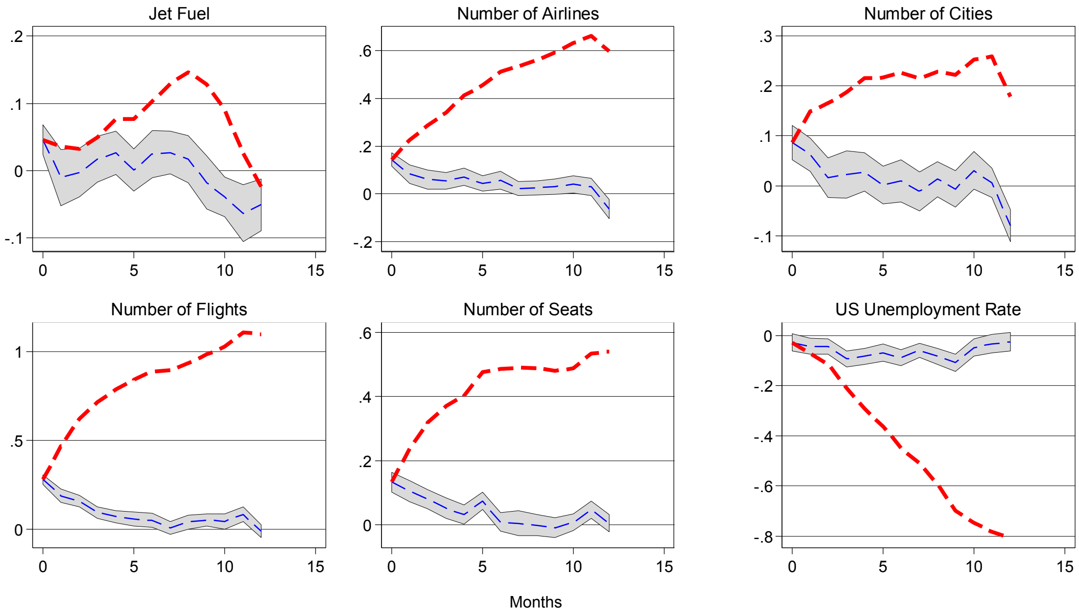
Note: Upper left graph gives the seasonal pattern detected by the unobserved component model; Bottom left represents the filtered series (eliminated the seasonal components); Bottom right gives the autocorrelation function of the filtered series. We can see the autocorrelation function looks like a AR process after filtering out the seasonality.

Figure A3. Response of Tourist Arrivals to Different Shocks (specification with vacancy rate, panel VAR)



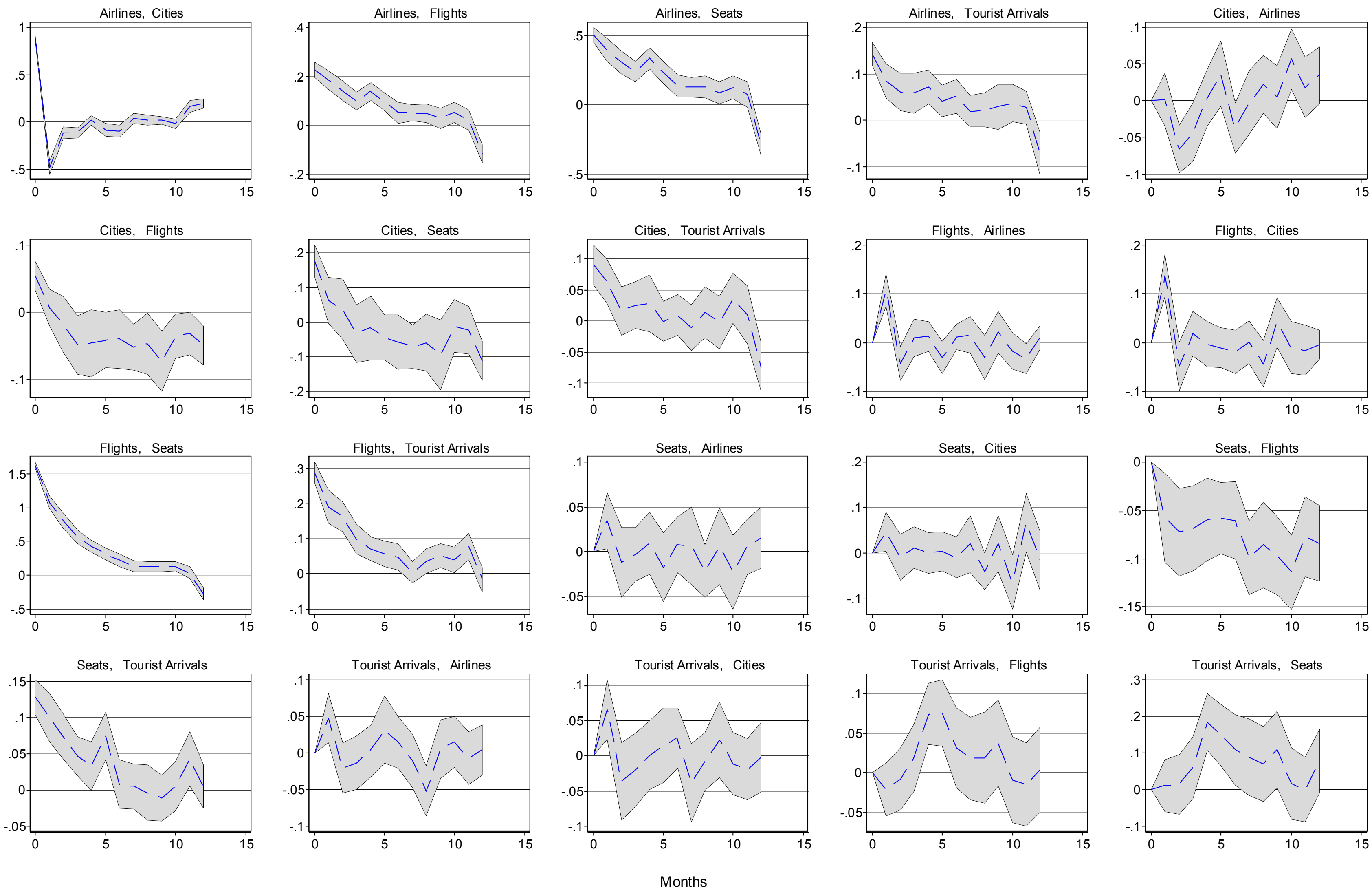
Notes: The blue dashed represents the percentage deviation from the steady state of the response variable (tourist arrivals) to a one percent positive shock of the impulse variable. The shaded area is the 90% confidence interval and the red dashed line shows the cumulative percentage change of tourist arrivals.

Figure A4. Response of Tourist Arrivals to Different Shocks (specification including jet fuel, panel VAR)



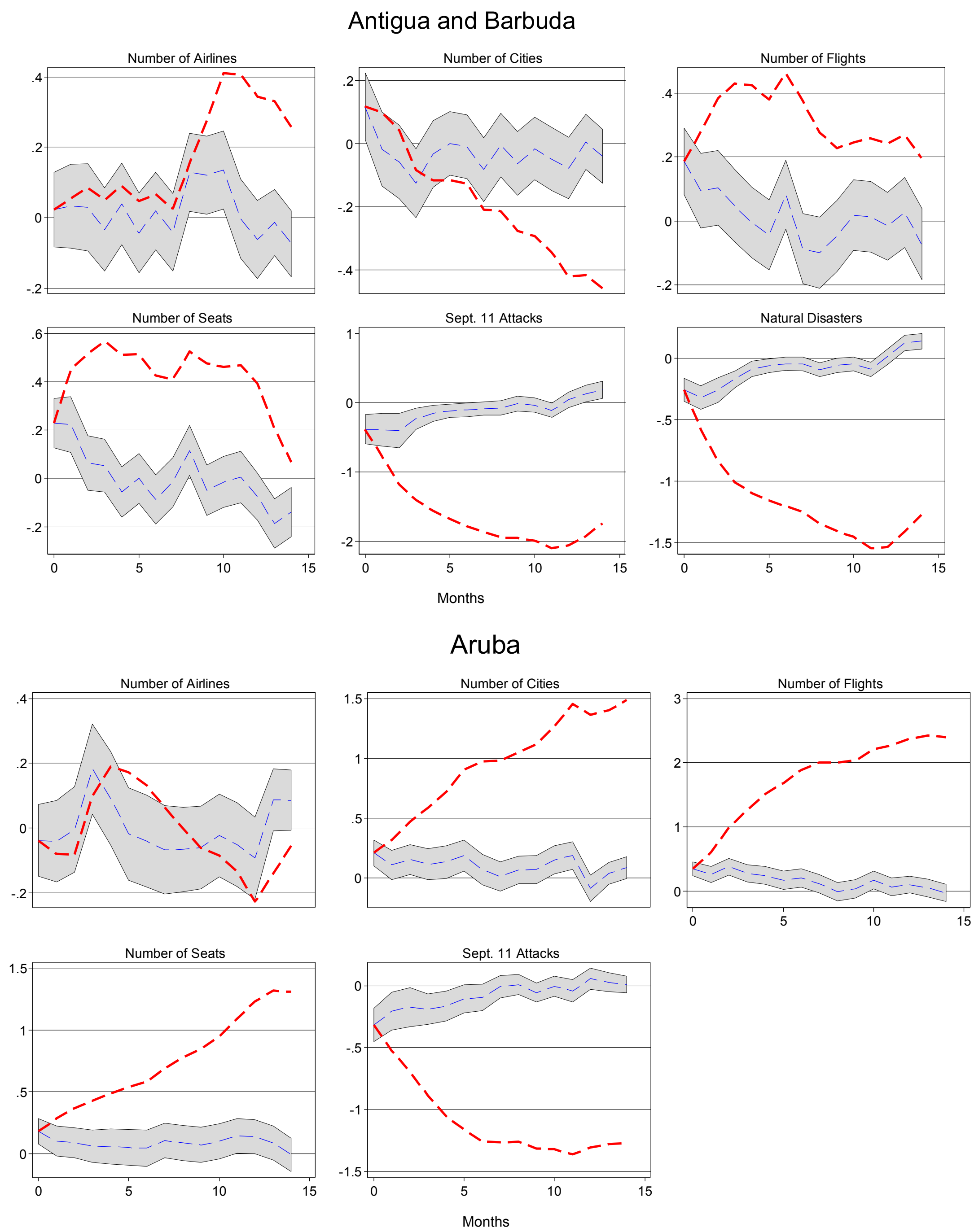
Notes: The blue dashed represents the percentage deviation from the steady state of the response variable (tourist arrivals) to a one percent positive shock of the impulse variable. The shaded area is the 90% confidence interval and the red dashed line shows the cumulative percentage change of tourist arrivals.

Figure A5. Impulse Response Functions (benchmark specification, panel SVAR)



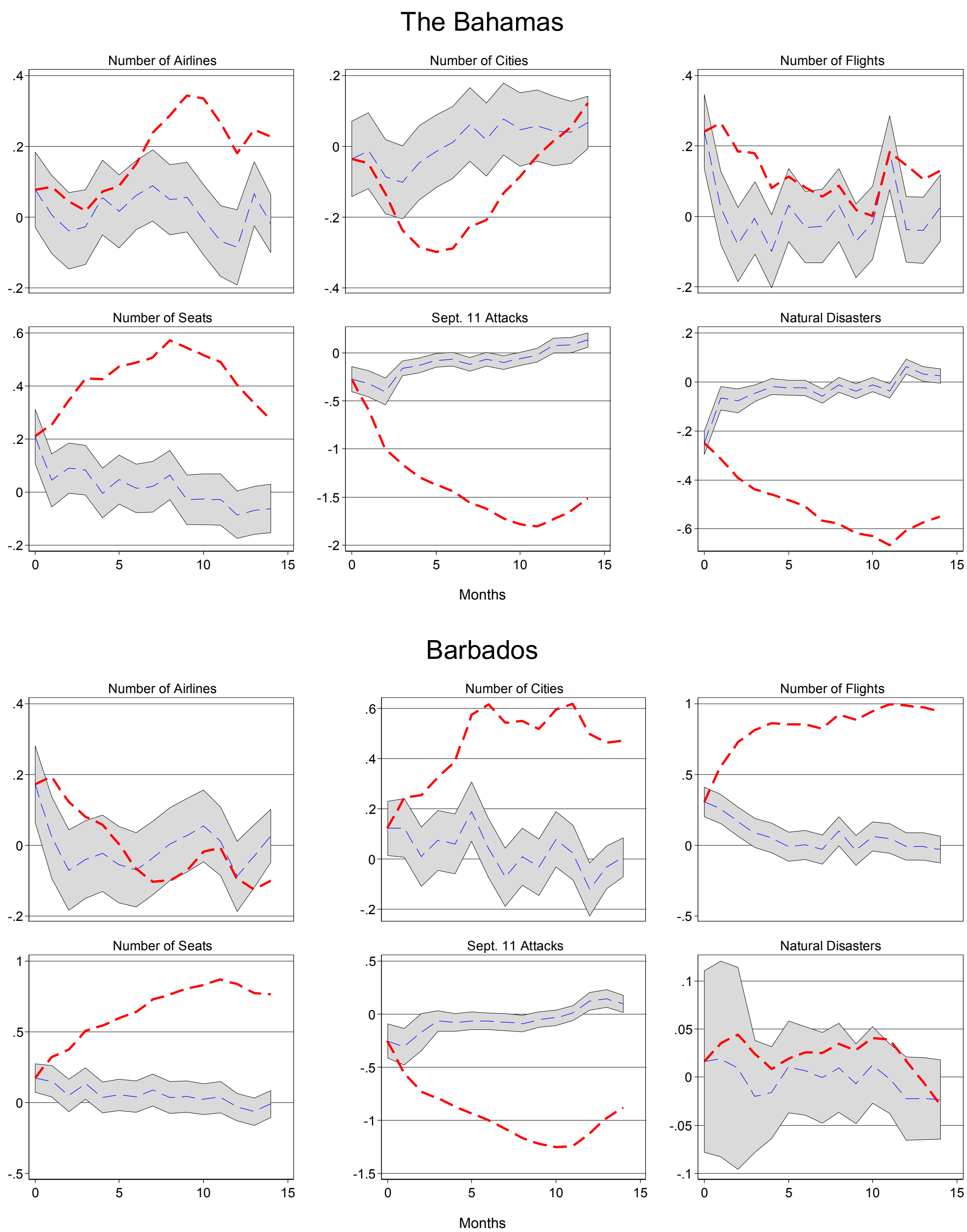
Notes: The title of the sub graphs indicates "the impulse variable, the response variable". The horizontal axis represents percentage deviation from the steady state in response to a 1% positive shock. The shaded area is the 90% confidence interval and the red dashed line shows the cumulative percentage change of tourist arrivals.

Figure A6. Response of Tourist Arrivals to Different Shocks (country SVAR Results)



Notes: The blue dashed line represents the percentage deviation from the steady state of the response variable (tourist arrivals) to a one percent positive shock of the impulse variable. The shaded area is the 90% confidence interval and the red dashed line shows the cumulative percentage change of tourist arrivals.

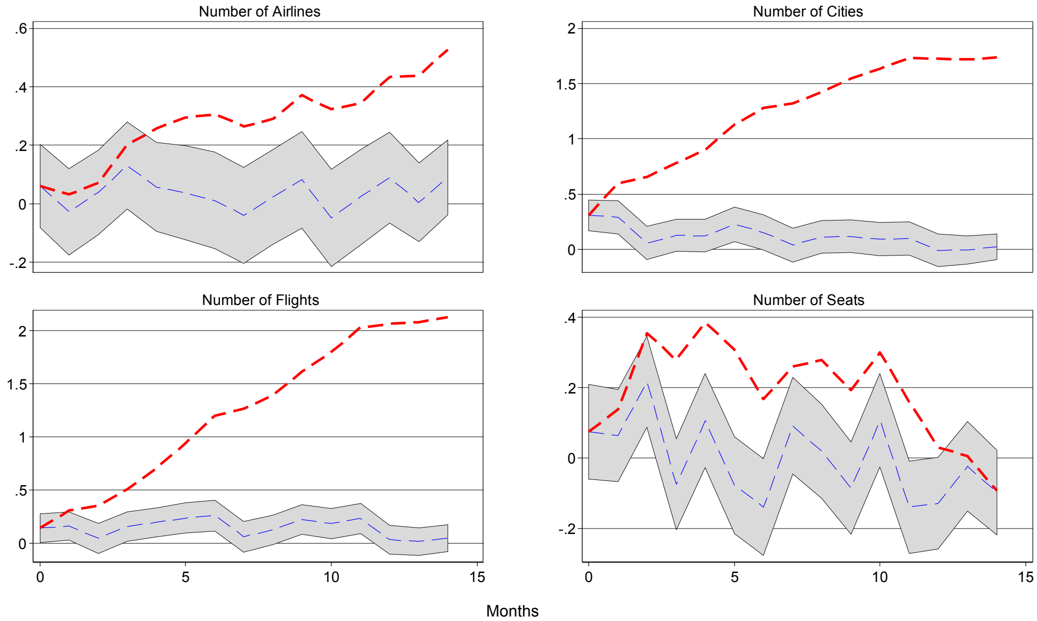
Figure A6. Response of Tourist Arrivals to Different Shocks (country SVAR Results)



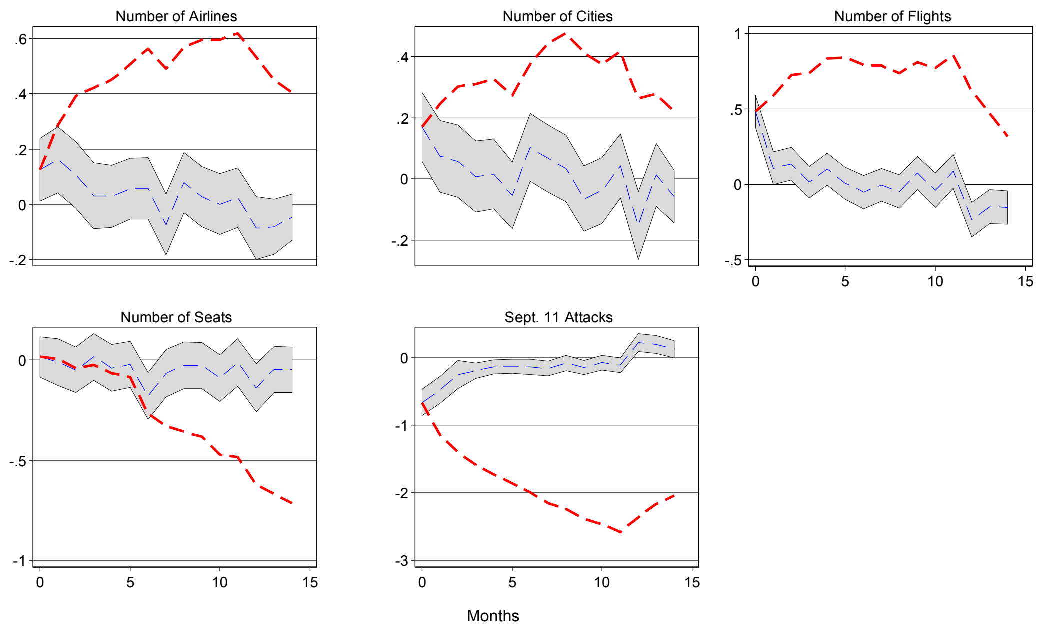
Notes: The blue dashed line represents the percentage deviation from the steady state of the response variable (tourist arrivals) to a one percent positive shock of the impulse variable. The shaded area is the 90% confidence interval and the red dashed line shows the cumulative percentage change of tourist arrivals.

Figure A6. Response of Tourist Arrivals to Different Shocks (country SVAR Results)

Belize

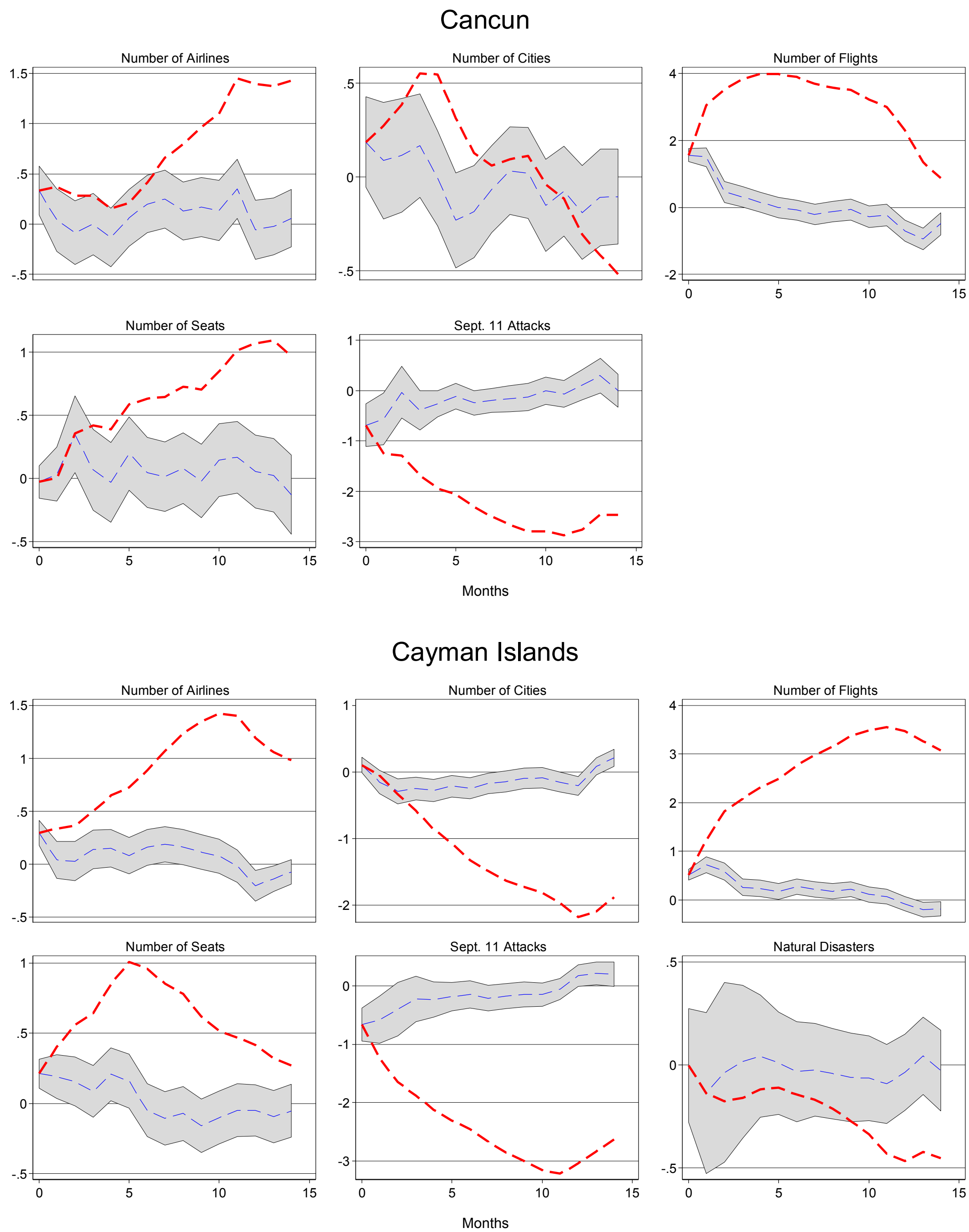


Bermuda



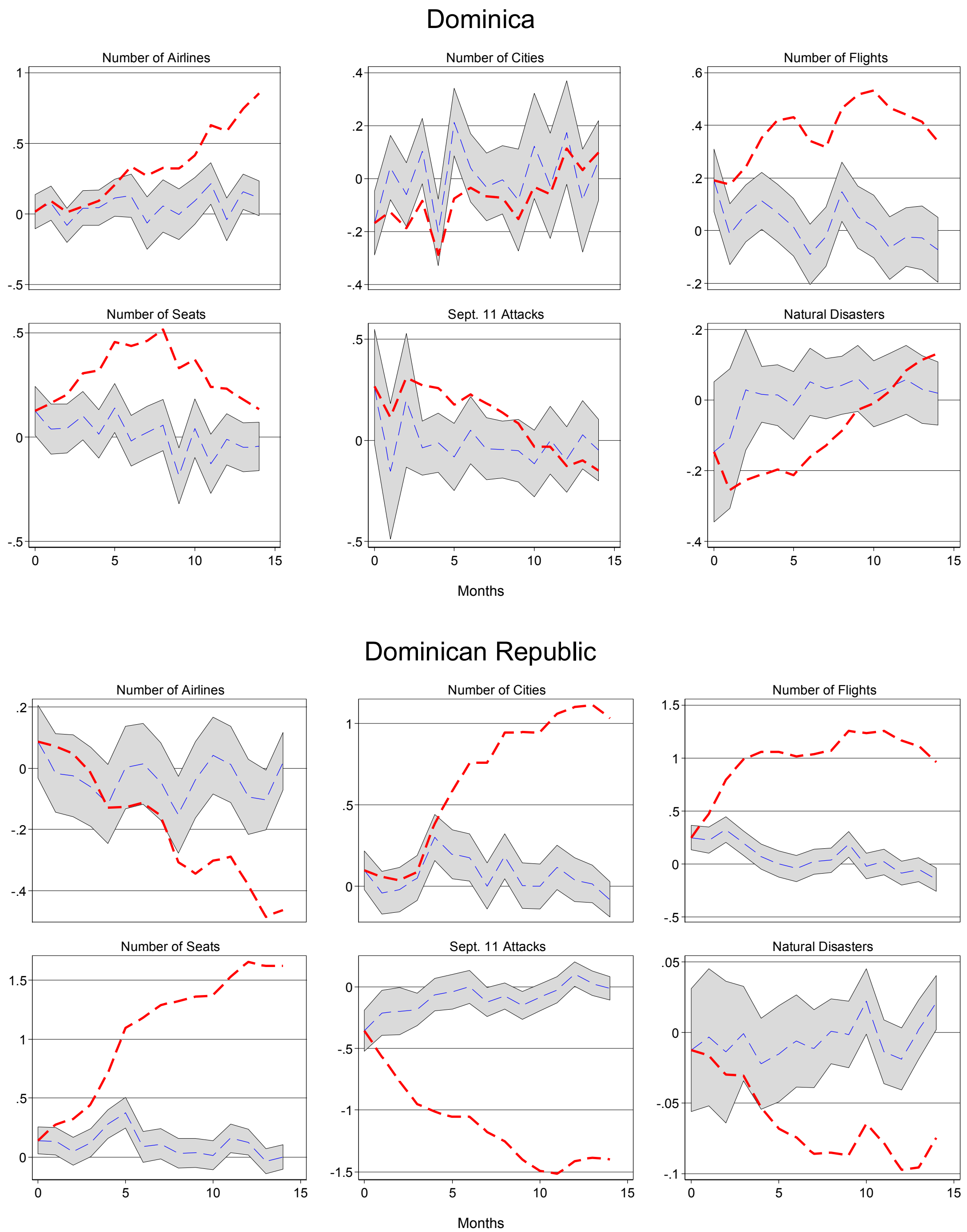
Notes: The blue dashed line represents the percentage deviation from the steady state of the response variable (tourist arrivals) to a one percent positive shock of the impulse variable. The shaded area is the 90% confidence interval and the red dashed line shows the cumulative percentage change of tourist arrivals.

Figure A6. Response of Tourist Arrivals to Different Shocks (country SVAR Results)



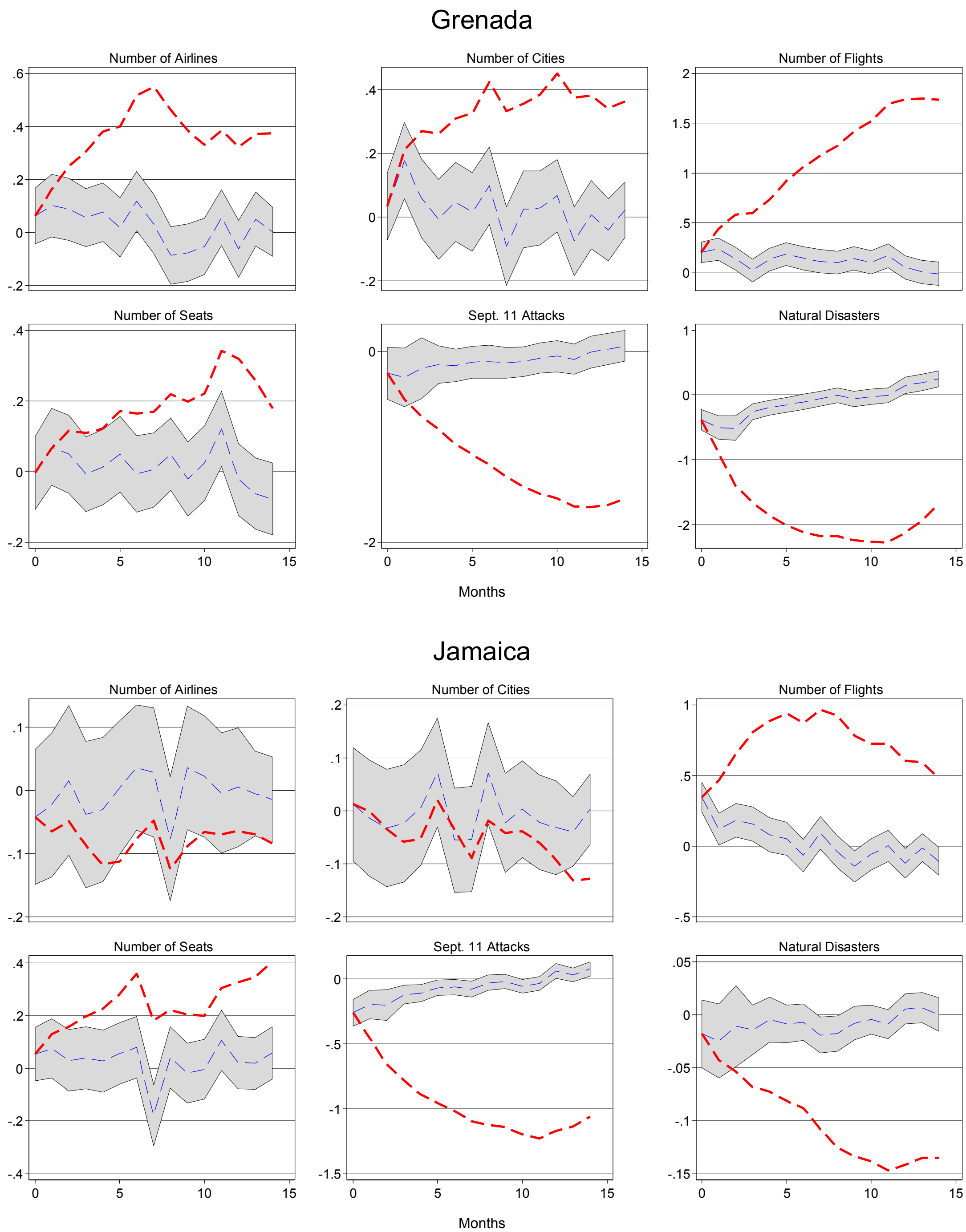
Notes: The blue dashed line represents the percentage deviation from the steady state of the response variable (tourist arrivals) to a one percent positive shock of the impulse variable. The shaded area is the 90% confidence interval and the red dashed line shows the cumulative percentage change of tourist arrivals.

Figure A6. Response of Tourist Arrivals to Different Shocks (country SVAR Results)



Notes: The blue dashed line represents the percentage deviation from the steady state of the response variable (tourist arrivals) to a one percent positive shock of the impulse variable. The shaded area is the 90% confidence interval and the red dashed line shows the cumulative percentage change of tourist arrivals.

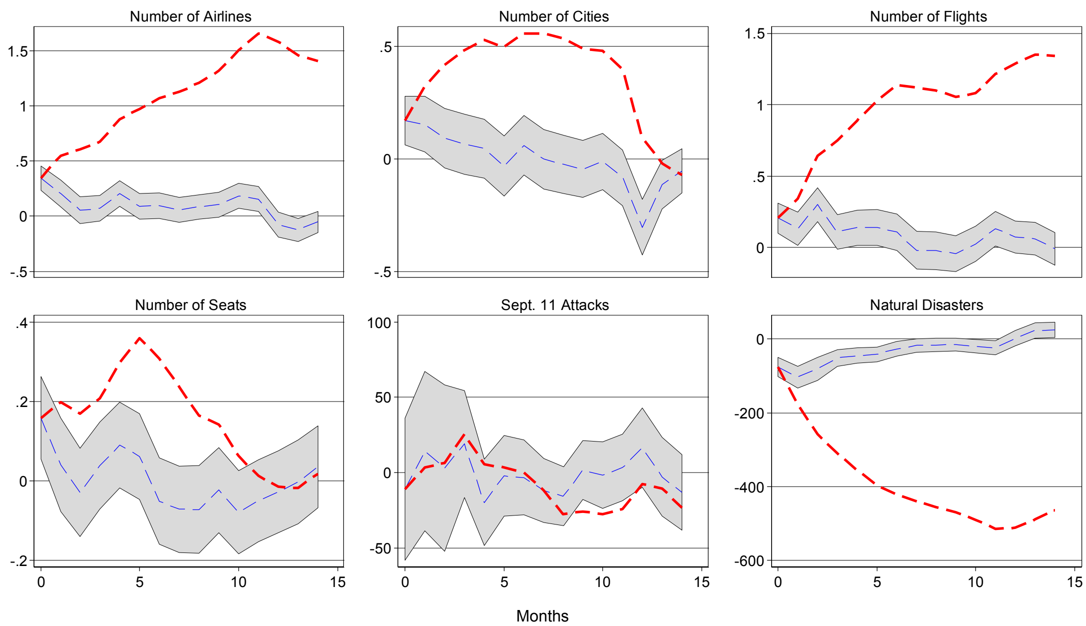
Figure A6. Response of Tourist Arrivals to Different Shocks (country SVAR Results)



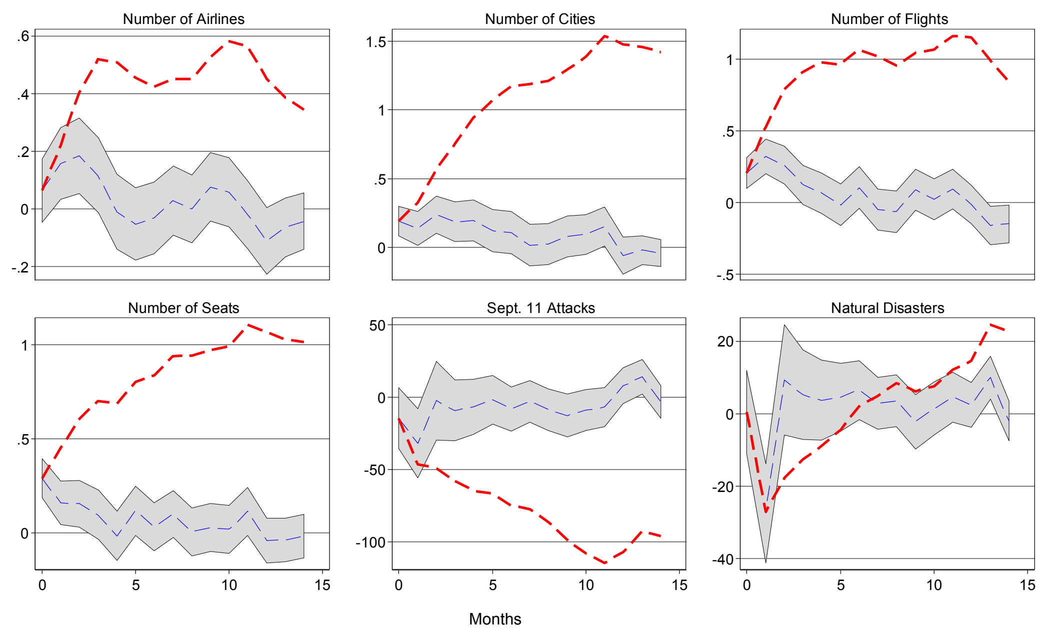
Notes: The blue dashed line represents the percentage deviation from the steady state of the response variable (tourist arrivals) to a one percent positive shock of the impulse variable. The shaded area is the 90% confidence interval and the red dashed line shows the cumulative percentage change of tourist arrivals.

Figure A6. Response of Tourist Arrivals to Different Shocks (country SVAR Results)

St. Kitts and Nevis

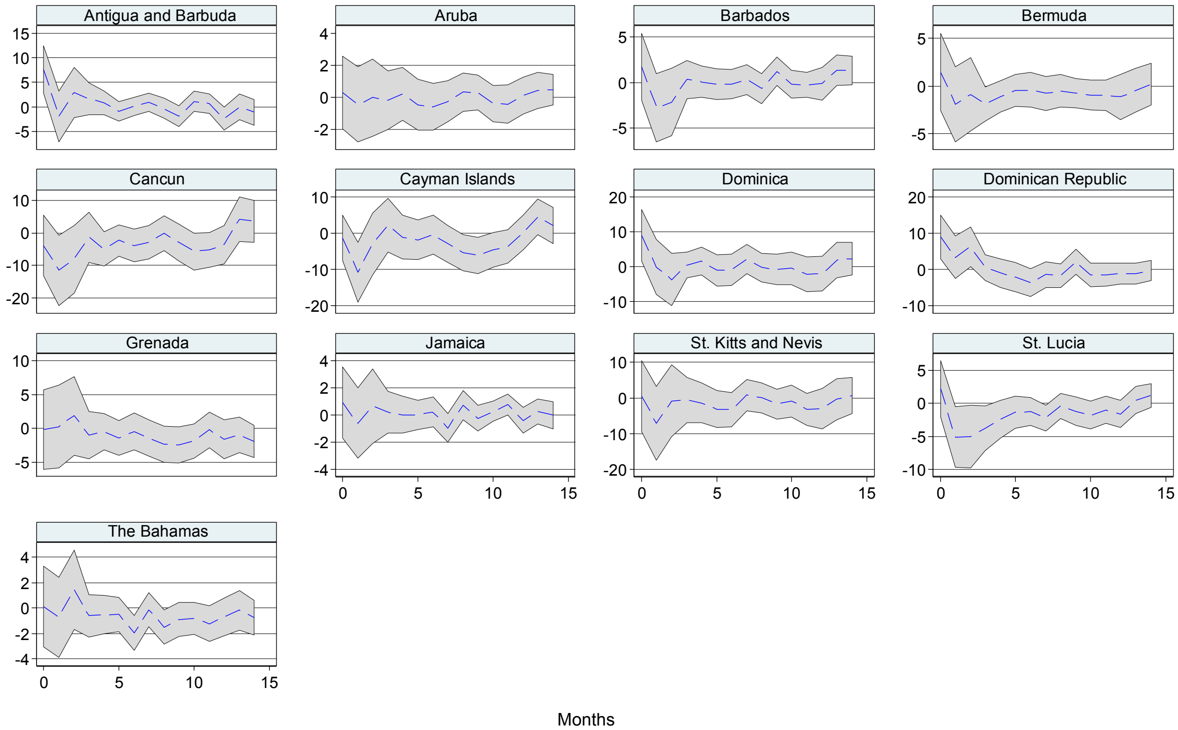


St. Lucia



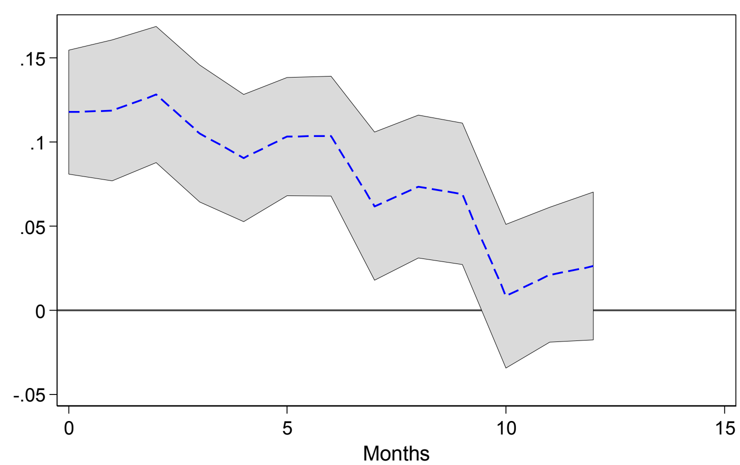
Notes: The blue dashed line represents the percentage deviation from the steady state of the response variable (tourist arrivals) to a one percent positive shock of the impulse variable. The shaded area is the 90% confidence interval and the red dashed line shows the cumulative percentage change of tourist arrivals.

Figure A7. Response of Tourist Arrivals to a Natural Disaster Shock in Another Country (specification with natural disasters affecting other countries, country SVARs)



Source: Authors' calculations based on country specific SVARs.
Notes: The shaded area is the 90% confidence interval and the blue dashed line represents the percentage deviation from the steady state of the response variable (tourist arrivals) after a natural disaster in another Caribbean country.

Figure A8. Response of Flights to an Increase in Flights to the Dominican Republic Shock



Source: Authors' calculations based on the panel SFiVAR.
Notes: Impulse: the number of flights to the Dominican Republic. The shaded area is the 90% confidence interval.