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# How elastic are sea, sand and sun? Dynamic panel estimates of the demand for tourism

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This paper employs recent advances in dynamic panel data analysis to study the determinants of tourist flows to the Caribbean. Consistent with the theoretical literature, the results are found to be highly sensitive to estimation technique. The preferred GMM system suggests income and price elasticities substantially above those found in the literature.

## I. Introduction

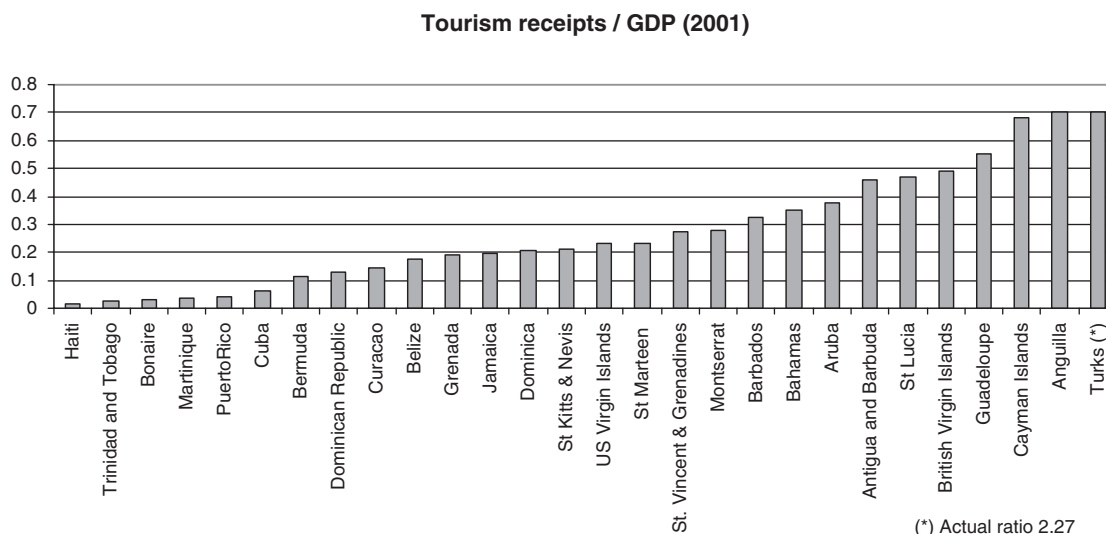
For many small developing countries, tourist income constitutes the largest ‘export’ and often exceeds a quarter of GDP (see Fig. 1). As traditional agro export industries decline in the Caribbean, tourism is increasingly looked to as a source of long run and sustainable growth. However, there is concern that a high price elasticity for the relatively homogeneous package of sea, sand, and sun may be driving the perceived volatility of revenues and the observed erosion of the region’s share of the global market.

As Lim (1997) documents, a large number of papers over the years have been published using a variety of specifications and data sets. Choosing a couple solidly done studies yields wide variance in estimates. One of the very few works on the Caribbean (Rosensweig, 1988) employs a multilevel CES SUR model, and finds elasticities of substitution of islands with each other of 1.33 to 2.45, with Mexico 1.85 to 1.00 and with Europe 1.7, depending on whether the origin was restricted to the USA or all countries. Rosensweig’s estimates are broadly in line with those of Papatheodoru (1999) who estimates a model in levels for the Mediterranean region for tourists from

France, Germany and UK, and finds price elasticities greater than 1. However, Garín-Muñoz and Pérez Amaral (2000) estimate a dynamic model in levels and a non-dynamic differences specification on the determinants of tourist flows to Spain and obtain price elasticities of only 0.30 and 0.25 respectively. Song *et al.* (2000) working in an error correction framework on single country data obtain price elasticities that range from 0 to 2 for the principal destination countries of English tourists. Estimated income elasticities tend to confirm the intuition of the sector as being a luxury good although there is also substantial variance. Garín-Muñoz and Pérez Amaral find elasticities of 0.97 and 0.91 and Song *et al.* (2000) of around 2.

This paper constructs a new panel of data on tourist flows from eight origin countries to 29 Caribbean destinations from 1990–2002, employs modern panel unit root tests, and then estimates dynamic specifications of tourism demand. Since the recent finite  $T$  dynamic panel literature suggests that results are extremely sensitive to an estimation technique, standard fixed effects are employed, the Arellano and Bond (1991) GMM difference, and the Blundell and Bond (1998) GMM system estimators to test

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**Fig. 1. Tourism Receipts / GDP (2001)**

**Table 1. Summary statistics**

	Obs.	Mean	Std.dev.	Min.	Max.
<i>ltour</i>	2372	1.728	2.394	-6.907	8.035
<i>lrer</i>	2880	-0.085	0.208	-0.891	0.840
<i>lgdppc</i>	2880	10.044	0.239	9.543	10.39

robustness. The theoretical concerns around their individual bias properties are found to be supported and of important magnitude.

## II. Data

The Caribbean Tourism Organization (CTO) tabulates time series on tourist flows by destination and origin from the statistical and tourism offices of its 32 member states plus Cancun, Mexico in the annual *Caribbean Tourism Statistical Report*. Here the focus on stay-over tourists which constitute the larger and more lucrative market, and flows from the USA, Canada, UK, France, Germany, Netherlands, Italy and Spain which account for more than the 75% of demand.<sup>1</sup> Income and bilateral real exchange rates

by origin/island pair are taken from the World Development Indicators (WDI, 2001). Table 1 reports summary statistics.

## III. Results

Readers are referred to the authors above for detailed treatment of the estimation methods and only a sketch of the issues can be presented here. A standard log-linear autoregressive specification is used initially:

$$\begin{aligned}
 tour_{ijt} = & \eta_{tour} tour_{ij(t-1)} + \sum_{k=0}^K \left( \eta_{rer(t-k)} rer_{ij(t-k)} \right. \\
 & \left. + \eta_{Q(t-k)} Q_{j(t-k)} \right) \\
 & + \mu_t + \mu_{ij} + \varepsilon_{ijt}
 \end{aligned}$$

where  $tour_{ijt}$  denotes tourist arrivals to island  $i$  from origin  $j$ ,  $rer_{ijt}$  the real exchange rate defined above,  $Q_{jt}$  a measure of the income of the country of origin (GDP per capita),  $\mu_{ij}$  and  $\mu_t$  island/tourist- and year-specific effects, and  $\varepsilon_{ijt}$  is the regression error term. All variables are in logs so the  $\eta$  coefficients are the relevant short run elasticities.

As preliminary examination of the data, we follow Levin, Lin and Chu (2002) tests for unit roots in

<sup>1</sup> This disaggregated approach helps compensate for the lack of reliable data on duration of stay. The sketchy available data suggests that the duration of individual nationalities is reasonably constant over time implying that percentage change in entrants is a reasonable proxy for change in tourist demand for services. However, US tourists show substantially shorter spells than Europeans. Aggregate estimations may therefore conceal compositional changes and hence true changes in tourist demand.

panel data in estimating the following AR(1) process

$$\Delta y_{ijt} = \eta_{ij} + \delta y_{ij(t-1)} + \varepsilon_{ijt}$$

allowing for an individual-specific mean, alternating with constant and trend. The null hypothesis that each individual time series contains a unit root ( $\delta=0$ ) against the alternative hypothesis that each time series is stationary ( $\delta < 0$ ). Except for log of tourist arrivals without trend and constant, the hypothesis that each variable has a unit root (Table 2) is rejected although the series do show high levels of persistence.

Table 3 presents estimates of the model using three techniques. The assumption of a lack of correlation between  $\mu_{ij}$  and the explanatory variables required

for the random effects estimator is not defensible in this context and is not presented. The standard fixed effects estimator for comparison purposes though the usual elimination of  $\mu_{ij}$  by subtracting off the time mean induces a negative correlation between the transformed error and the lagged dependent variable (LDV) that induces bias of order  $1/T$ , which, in short panels such as those used here is substantial.

The next two columns following Arellano and Bond (1991) difference the data to eliminate  $\mu_{ij}$ , yielding:

$$\begin{aligned} \Delta tour_{ijt} = & \eta_{tour} \Delta tour_{ij(t-1)} + \sum_{k=0}^K \left( \eta_{rer(t-k)} \Delta rer_{ij(t-k)} \right. \\ & \left. + \eta_{Q(t-k)} \Delta Q_{j(t-k)} \right) \\ & + \Delta \mu_t + \Delta \varepsilon_{ijt} \end{aligned}$$

**Table 2. Levin et al. (2002) test for unit root**

	None		Constant		Constant and trend	
	t-star	Obs.	t-star	Obs.	t-star	Obs.
ltour <sup>1</sup>	-1.07	1661	-12.44	1661	-24.43	1661
lrer	-11.9	2640	-9.7	2640	-17.3	2640
lgdppc	-7.10	2640	-3.98	2640	-29.47	2640
lrer <sup>1</sup>	-8.80	1661	-5.48	1661	-15.30	1661
lgdppc <sup>1</sup>	-4.30	1661	-3.14	1661	-26.17	1661

Note: <sup>1</sup>Observations were dropped to obtain a complete panel.

where  $\Delta$  is the time-difference operator. Unless the idiosyncratic error followed a random walk, this differencing necessarily gives the transformed error an MA(K) structure that is correlated with the differenced LDV and perhaps the real exchange rate. This can be overcome by using instruments dated  $t-K$  and earlier. Arellano and Bond's (1991) employment of additional lags as instruments to improve the efficiency of the estimates in a

**Table 3. Dynamic panel estimates**

	Fixed effects		Difference GMM		System GMM	
ltour <sub>t-1</sub>	0.492	0.450	0.336	0.283	0.963	0.968
	(0.019)	(0.021)	(0.080)	(0.093)	(0.012)	(0.013)
lrer <sub>t</sub>	0.091	0.133	0.199	0.194	0.323	0.264
	(0.103)	(0.112)	(0.158)	(0.190)	(0.119)	(0.134)
lrer <sub>t-1</sub>	0.315	0.226	0.399	0.291	-0.038	0.176
	(0.100)	(0.133)	(0.129)	(0.121)	(0.097)	(0.141)
lrer <sub>t-2</sub>	-	0.056	-	0.202	-	-0.284
		(0.099)		(0.129)		(0.096)
lgdppc <sub>t</sub>	3.583	4.388	4.396	4.903	3.842	1.515
	(0.841)	(1.298)	(1.465)	(1.787)	(0.975)	(1.393)
lgdppc <sub>t-1</sub>	-0.143	-1.288	-0.0312	-0.533	-3.703	0.543
	(0.869)	(1.685)	(1.245)	(1.929)	(0.949)	(2.048)
lgdppc <sub>t-2</sub>	-	0.939	-	0.441	-	-1.993
		(0.993)		(1.549)		(0.982)
Long-run price elasticity	0.80	0.75	0.90	0.96	7.70	4.9
Long-run income elasticity	6.77	7.34	6.57	6.71	3.75	2.03
Obs.	2145	1976	1921	1752	2145	1976
Groups	220	220	217	217	220	220
Hansen test	-	-	151	148	206	194
			(149)	(136)	(209)	(198)
AR(1) test	-	-	-4.08	-3.87	-3.33	-3.07
AR(2) test	-	-	1.17	1.13	1.24	1.22

Notes: One-step robust estimation. All specifications included a complete set of time dummies. Standard errors in parentheses except for Hansen test: degrees of freedom of Chi2. RER is treated as an endogenous variable and GDP per capita as predetermined in GMM estimation.

Generalized Method of Moments (GMM) context is followed.

The unit root tests suggest that the tourism series has very high persistence. Blundell and Bond (1998) suggest that this may imply that lagged levels are bad instruments that can lead to serious finite sample downward bias, particularly in the LDV. Since the correct estimation of the LDV is critical to calculating long run price elasticities, the results of their system estimator is reported, which incorporates information from the levels regression instrumented with lagged differences and has better bias properties with persistent series.

Since with the final estimator, two lags of the explanatory variable appear significant, this specification is reported for all techniques to be comparable. In all cases, the relevant diagnostics suggests the specifications are satisfactory in terms of both serial correlation and Hansen test for instrument quality.

The fixed effect estimator suggests important dynamics coming through the lagged dependent variable with values of 0.49 and 0.45. These fall to 0.34 and 0.28 in the difference GMM specification. Confirming that this low value is likely to be the result of the weak instruments problem, when moving to the system estimator, the LDV coefficient jumps to over 0.96 in both specifications and for both explanatory variables, the second lag now enter significantly. The relative magnitudes of these estimates on the LDV are consistent with theory and clearly have an impact on the estimated long-run price elasticities: both the fixed effect and difference estimator generate quite similar results at 0.75 and 0.96 respectively while the system estimator generates a very large 4.9.

The dramatic shift from tourism being relatively inelastic, to it being extraordinarily elastic is somewhat disconcerting, but the system is retained as the preferred estimator because of the likely presence of the weak instruments problem. Further, the critical additional assumption for the validity of the differenced instruments in the levels component of the system – that changes in the dependent variable are uncorrelated with the unobserved fixed effect or, alternatively put, that the initial distribution of

tourism flows is at the steady-state and remains constant across the sample – seems plausible given the maturity of the industry in the early 1990s and the persistence of the relative ordering of the series.

All estimates of the income elasticity suggest that, consistent with intuition, tourism is income elastic and a luxury good. Here, however, the system estimator leads to a substantially lower estimate than the other techniques at 2.03, a value consistent with, although at the higher end of, previous estimates.

#### IV. Conclusion

This paper employs recent advances in dynamic panel data analysis to estimate the demand for tourism using a new panel on flows to the Caribbean. Consistent with the theoretical literature, the results are found to be highly sensitive to estimation technique. The preferred specification suggests a very high price elasticity of close to 4.9, and confirms that tourism is a luxury good with income elasticity above 2.

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