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Research note

Nonlinear ARDL estimation of tourism demand for Puerto Rico from the USA

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ABSTRACT

This study estimates the long-run demand for tourism for Puerto Rico (1970–2016) from the USA. Since income elasticity may not be symmetric through business cycles, it becomes necessary to account for the asymmetric impact of changes in income on tourism demand. To this end, the study utilizes the nonlinear ARDL framework of Shin et al. (2014) to investigate the asymmetric cointegration. The results indicate the existence of an asymmetric or nonlinear cointegration relationship between Puerto Rico's tourism demand and its determinants. The long-run asymmetric income elasticities suggest that a 1% increase in US's real per capita GDP leads to a 1.9% increase in Puerto Rico's tourism earnings, while a 1% decrease in US's real per capita GDP produces a 4.8% reduction in tourism receipts.

1. Introduction

A number of studies estimated tourism demand for various destinations using a variety of approaches. An extensive review of studies on tourism demand is provided in Song, Qiu, and Park (2019). However, Puerto Rico (PR) is overwhelmingly an understudied case, when compared to many other tourist destinations. This study attempts to fill that gap. Understanding the significant factors that affect the demand for tourism becomes critical in helping policy makers and the industry in developing strategies to brand PR as a more attractive alternative to visitors. We expect this study to inform policy decisions of public and private interests in those regards.

The main source of tourism for PR is from the USA, as 90% of the island's visitors are from the mainland (Perfil de los Visitantes, 2012). Therefore, overall fluctuations in the US′ economy are hypothesized to have a significant impact on the island's tourism earnings and hence, economic growth. Additionally, the island competes for American tourists with other Caribbean destinations. Accordingly, this study considers USA's real income, own price, price in competing destinations, and a measure of transportation cost to be the main determinants in estimating PR's tourism demand.

The novelty of this study is that we initially employ a benchmark dynamic linear autoregressive distributed lag (L-ARDL) cointegration model as introduced by Pesaran, Shin, and Smith (2001), henceforth PSS, assuming that USA's real income has a symmetric short- and long-run impact on tourism demand. Then, we examine whether the dynamic short- and long-run impact of USA's real income on PR's tourism demand is asymmetric. According to Smeral (2012, 2014), tourism income elasticities can differ across the business cycle due to "loss aversion" in addition to liquidity constraints, precautionary savings, and increases in indebtedness of households due to habit modification. To this end, we employ the recently developed asymmetric cointegration or nonlinear (NL-ARDL) developed by Shin, Yu, and Greenwood-Nimmo (2014), henceforth SYG. To the best of our knowledge, this study is both the first to estimate a long-run tourism demand for PR, and the first utilizing the newly developed NL-ARDL approach in estimating such demand function.

2. Empirical model, data, and estimation

2.1. Model and data

In light of the existing literature, the following is the proposed model to estimate PR's tourism demand:

$$TR_t = \alpha_0 + \alpha_1 GDPPC_t + \alpha_2 OP_t + \alpha_3 BP_t + \alpha_4 TC_t + \varepsilon_t \quad (1)$$

where *TR* is PR's real tourism receipts, *GDPPC* is USA's real per capita, *OP* is own or tourist price (i.e., cost of vacationing in PR relative to

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home), as CPI_{pr}/CPI_{usa}; *BP* is the competing destination (the Bahamas) price, as CPI_{bah}/CPI_{pr}; *TC* is transportation cost proxied by air transportation price index; ε_t is the error term; α_1, α_2, α_3, and α_4 are long-run elasticities.[1] All variables are annual from 1970 to 2016, in natural logarithm, and measured in real terms (2010 = 100). Data are obtained from the U.S. Federal Reserve Bank Federal Reserve Economic Data, 2017, and Puerto Rico Planning Board Apéndice estadístico,.

2.2. Estimation

NL-ARDL cointegration testing and estimation technique is an asymmetric extension of the L-ARDL model of PSS's cointegration and error correction approach. Therefore, all advantages of the L-ARDL approach carry over to the NL-ARDL method, as shown by SYG.[2] Since a subset of regressors enters the long-run relationship symmetrically, we follow SYG and introduce the following partial long-run asymmetric regression:

$$y_t = \beta^+ x_t^+ + \beta^- x_t^- + \gamma' w_{t-1} + \mu_t \quad (2)$$

here $x_t\ (= x_0 + x_t^+ + x_t^-)$ is a $k \times 1$ vector of regressors entering the model asymmetrically (*GDPPC*), w_t is a $g \times 1$ vector of regressors entering symmetrically (*OP*, *JP*, *BP*, and *TC*), β^+, β^-, and γ' are a vector of long-run parameters, x_0 is the initial value, and μ_t is a stationary zero-mean error process representing deviations from the long-run equilibrium. $x_t^+ + x_t^-$ are partial sum processes which accumulate positive and negative changes in x_t such as:

$$x_t^+ = \sum_{j=1}^{t} \Delta x_j^+ = \sum_{j=1}^{t} \max(\Delta x_j, 0) \quad (3)$$

$$x_t^- = \sum_{j=1}^{t} \Delta x_j^- = \sum_{j=1}^{t} \min(\Delta x_j, 0) \quad (4)$$

equation (2) can be framed into an asymmetric error correction model or an NL-ARDL (*p*, *q*) in a setting similar to the L-ARDL of PSS by including asymmetric and symmetric short- and long-run parameters:

$$\Delta y_t = \mu + \rho y_{t-1} + \theta^+ x_{t-1}^+ + \theta^- x_{t-1}^- + \theta_w w_{t-1} + \sum_{i=1}^{p-1} \gamma_i \Delta y_{t-i} + \sum_{i=0}^{q-1} (\pi_i^+ \Delta x_{t-i}^+ + \pi_i^- \Delta x_{t-i}^- + \pi_{w,i} \Delta w_{t-i}) + e_t \quad (5)$$

To determine the presence of cointegration among tourism demand variables, we first apply the *F*-statistic, F_{PSS}, to test the significance of the lagged levels of all variables in the unrestricted error correction model in equation (5), i.e., H_O: $\rho = \theta^+ = \theta^- = \theta_w = 0$. If that hypothesis is rejected, we then apply the bounds procedure to the cointegration test proposed by Banerjee, Dolado, and Mestre (1998), which is based on the *t*-test, denoted as t_{BDM}, that tests the significance of the coefficient on the lagged dependent variable in the NL-ARDL model (i.e., H_o: $\rho = 0$ against H_A: $\rho < 0$).[3]

A third step is to test the null hypotheses of long-run symmetry ($\theta^+ = \theta^-$) and short-run symmetry ($\pi_i^+ = \pi_i^-$ for all $i = 0, \ldots, q - 1$ or the less restrictive case $\sum_{i=0}^{q-1} \pi_i^+ = \sum_{i=0}^{q-1} \pi_i^-$) using Wald statistics following an asymptotic χ^2 distribution. In the case that both null hypotheses are not rejected, the traditional linear ECM model is more appropriate, an indication that no asymmetry is detected between *TR* and *GDPPC*.[4]

Table 1
Dynamic asymmetric error correction estimation (NL-ARDL) of tourism demand for PR.

Variable	Coefficient	*t*-Statistic	Prob.
C	−1.55	−0.59	0.56
TR(-1)	−1.22	−8.99	0.00
GDPPC⁺(-1)	2.31	8.04	0.00
GDPPC⁻(-1)	5.89	5.38	0.00
BP(-1)	1.74	6.40	0.00
TC(-1)	−0.10	−1.60	0.12
OP(-1)	0.50	1.46	0.16
ΔOP	−1.34	−4.26	0.00
ΔBP(-1)	−1.39	−4.33	0.00
ΔTR(-1)	0.35	3.61	0.00
ΔGDPPC⁺(-2)	−2.05	−4.82	0.00
ΔGDPPC⁺(-3)	−0.97	−2.31	0.03
ΔOP(-2)	−1.03	−2.09	0.05
ΔGDPPC⁻(-1)	−3.15	−3.53	0.00
ΔBP(-2)	−1.04	−2.40	0.02
ΔOP(-3)	−1.14	−3.13	0.00
ΔTC(-3)	0.18	2.17	0.04
ΔGDPPC⁻	2.27	2.67	0.01
Long-run asymmetric effects			
GDPPC⁺		1.88	
GDPPC⁻		4.81	
Statistics and diagnostics			
R^2		0.88	
Adj. R^2		0.71	
χ^2_{SC}		1.33 (0.51)	
χ^2_{NOR}		0.95 (0.62)	
χ^2_{HET}		19.0 (0.32)	
χ^2_{FF}		3.48 (0.062)	
t_{BDM}		−8.98	
F_{PSS}		14.58	
W_{LR}		23.5 (0.00)	
W_{SR}		7.02 (0.00)	

Notes: $GDPPC^+$ and $GDPPC^-$ denote the long-run coefficients associated with positive and negative changes of US's real per capita GDP, respectively. W_{LR} refers to the Wald test of long-run symmetry ($GDPPC^+(-1) = GDPPC^-(-1)$), while W_{SR} denotes the Wald test of additive short-run symmetry condition. PSS tabulate the t_{BDM} 1 and 5% upper bound, I (1), critical values for $k = 4$ as −4..60 and −3.99, respectively. Narayan (2004) tabulates F_{PSS} 1 and 5% upper bound finite sample, i.e., $n = 45$, and $k = 4$, critical values as 5.914 and 4.45, respectively.

3. Results

F_{PSS} and t_{BDM} test statistics results are reported in Table 1 along with the results of the conditional error correction regression. Statistically significant results are obtained with good adjusted R-squares and NL-ARDL estimates pass the standard diagnostic tests (serial correlation, normality, heteroscedasticity, and functional form). Recursive estimation of the conditional ECM and the associated plots of cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) suggest that the regression coefficients are generally stable over the sample period (see

[1] Other competing destinations, e.g. Jamaica and Mexico, were initially included in the model but both substitute destination prices were insignificant in both L-ARDL and NL-ARDL estimations.

[2] See PSS and SYG for more details.

[3] Many studies, in tourism and other areas, utilizing the L-ARDL and NL-ARDL bounds procedure, relied solely on the *F*-test to determine the presence of cointegration. To confirm a long-run relationship, once the *F*-statistics rejects its null hypothesis, one must also perform the *t*-test on the coefficient of the lagged dependent variable, as described in PSS (2001), SYG (2013), and Sam, McNown, and Soo (2019), to avoid a degenerate (no cointegration) case.

[4] Asymmetric cumulative dynamic multiplier effect, associated with a one-unit change in x_t^+ and x_t^- on y_t, are computed to analyze the time path of adjustment towards equilibrium following a positive or a negative shock affecting the system. These are available upon request.

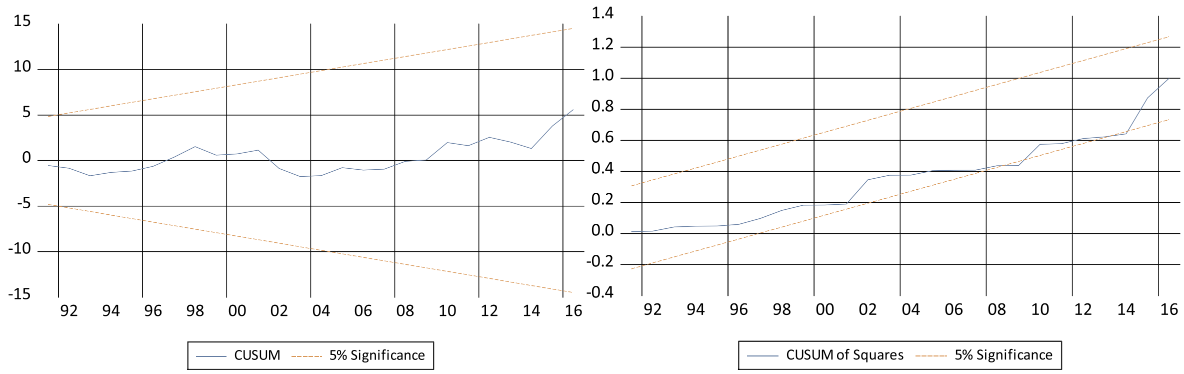

Fig. 1. NL-ARDL cumulative sum (CUSUM) and cumulative sum of square (CUSUMSQ).

Table 2
NL-ARDL long-run results.

Variable	Coefficient	*t*-statistic	Prob.
$GDPPC^{+}$	1.89	16.04	0.00
$GDPPC^{-}$	4.81	6.886	0.00
TC	−0.08	−1.568	0.13
OP	−0.41	1.480	0.15
BP	1.42	9.020	0.00
C	−1.26	−0.590	0.57

Notes: see Table 1.

Fig. 1).[5]

The F_{PSS} and t_{BDM} test statistics of 14.58 and −8.98 reported in Table 1 reject their respective null hypotheses using the more appropriate critical values of Narayan (2004) and the restrictive bounds approach of using k = 4 (i.e., the two partial sum variables are treated as one so that critical values used are more conservative). Next, the long- and short-run Wald tests, W_{LR} and W_{SR}, reported in Table 1, firmly reject the null hypothesis of long- and short-run symmetry at the 1% level.

These results confirm that an NL-ARDL model allowing long- and short-run asymmetry is best suited to describe the dynamic relationship between tourism demand variables.

The long-run results in Table 2 show that positive and negative changes in $GDPPC^{+}$ and $GDPPC^{-}$ both carry their expected positive sign and are highly significant. This suggests, all else constant, that a 1% increase in US's real GDP per capita will increase PR's tourism earnings by about 1.89%. However, a 1% decrease in US's real GDP per capita will lead to a 4.81% reduction in PR's tourism earnings. Overall results suggest that in the long-run, PR's tourism earnings are much more sensitive to the declines in overall economic activity in the US relative to its expansion. This is an indication that PR needs to diversify the sources of tourist arrivals. Similar to L-ARDL analysis, *OP* remains insignificant and *BP* continues to be a significant substitute destination with a cross-price elasticity of 1.42. However, TC turns insignificant in the nonlinear model.

4. Conclusions

Identifying the factors that affect the demand side of the tourism sector would help policy makers and private interests in their long- and short-term planning. With the aim of informing those debates, this study fills a gap in the literature and estimates the long-run demand for tourism for Puerto Rico for the 1970–2016 period.

The study also accounts for the asymmetric effects of income on tourism earnings, which cannot be captured by linear estimation techniques, such as the L-ARDL. Accordingly, we utilized the NL-ARDL method to examine the behavior of income elasticity. Results reveal the existence of a non-linear or asymmetric cointegration relationship where positive and negative changes in US's real per capita income have different effects on PR's tourism demand. A 1% decline in US's real per capita GDP would have a much higher downward impact on PR's tourism earnings compared to 1% increase in the US's real per capita GDP.

In light of the much heavier downward effect from the asymmetry of income elasticity, the authors recommend a concerted push toward diversification of the origin of visitors to the island. Hedging against the negative effects from the downturns of the US economy could be possible by balancing the dominance of (or overreliance on) US visitors through diversifying into alternative source countries. To that end, as controversial as it may be, a special visa waiver program for non-US nationals (limited to PR) should be considered in order to make the island a more attractive destination against Caribbean competitors. Currently, visitors from 160 countries are under costly and lengthy visitor visa requirements to land in PR. The Bahamas and the Dominican Republic list 166 and 95 countries that require no visa to visit, respectively, while Cuba lists only 19 countries whose nationals are required to obtain a visa. Alongside this, marketing efforts to promote the island in alternative markets should be implemented with intensity.

Authors contribution

Dr. Husein conceptualized the study and was responsible for the econometric analysis and the writing of the paper's first draft.

Dr. Kara provided the data, checked all the paper's estimations and was in charge of finalizing the paper and its conclusions.

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[5] Prior to implementing L-ARDL and NL-ARDL bounds cointegration tests, Lee and Strazicich (2003) unit root test is performed to ensure that the dependent variable, *TR*, is I(1) and none of the regressors are integrated of order exceeding one. L-ARDL point estimates and diagnostics are available upon request.

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