Investigating the impact of climate change on the tourism sector: evidence from a sample of island economies

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Abstract

Purpose – *Although it is a widely accepted fact that climate change can negatively impact on tourism demand and affect the economies at the socio-economic level, empirical studies on the climate change tourism development nexus has been quite scant, especially for the case of island economies that are heavily dependent on tourism. This study aims to supplement the literature on climate change and tourism by empirically assessing the relationship between climate change and tourist arrivals for the case of 18 small island developing states over the period from 1989 to 2016.*

Design/methodology/approach – *This paper uses dynamic panel data techniques, namely, a panel vector autoregressive framework, which accounts for dynamic and endogeneity issues.*

Findings – *The results from the analysis confirm the existence of a significant relationship between climate change and tourism demand in both the long-run and short run. Further analysis shows a bi-directional causality between climatic change and tourism demand while the study also confirms the tourism led growth hypothesis.*

Research limitations/implications – *This research supplements the literature on the tourism-environment link, especially for tourism dependent island economies.*

Practical implications – *Results from this study are important to policymakers who should spare no effort to mitigate the effect of adverse climatic change in the context of tourism development.*

Originality/value – *This study is built on a unique data set for a sample of island economies and interestingly adopts dynamic panel data analysis to account for dynamics and endogenity in the climate change-tourism development nexus.*

Keywords *Climate change, Island economies*

Paper type *Research paper*

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1. Introduction

The tourism sector is vital for the development of small island developing states (SIDS). This sector provides a flow of foreign exchange and creates employment both directly and indirectly and offers the opportunity for economic diversification. As identified by Ashley *et al.* (2007), the tourism sector has considerable amount of connection with other sectors of the economy which ultimately contribute to the growth of tourism related activities such as agriculture, fishing, industry and services, as well as transportation. In many island economies the tourism sector has become a major contributor to economic growth and it has also led to an inflow of foreign currency and job creation. For instance, currently, around 90 per cent of the gross national product in the Maldives comes from tourism, and a total of 70 per cent employment in the Bahamas is in the tourism industry.

The significant effect of the tourism sector on economic growth has motivated many researchers to study the main factors that determine the development of the tourism sector. Among the most important factors that have been identified in the literature are income

Received 30 December 2017
Revised 28 April 2018
30 April 2018
28 May 2018
Accepted 28 May 2018

DOI 10.1108/TR-12-2017-0204

derived from tourists, relative prices, political stability, socio-cultural and economic relations between countries, tourism and other infrastructure and also air access liberalisation. Increasing attention has been given lately to climate change as another factor that potentially affects the tourism demand. Indeed, island tourism is an industry which is subtle to climate given that these are mainly located in the coastal region and they are vulnerable to sea level rise. This would result in the flooding of coastal and some inland areas, menacing sanitation systems and freshwater supplies as seawater infiltrates subterranean water tables, with possibly catastrophic consequences for island tourism (U.C.C. Secretariat, 2005). Rughooputh (2002) observed that over the past 140 years, the global temperatures have increased by 0.6°C on average, with the sea level also recording an increase. It is further predicted that temperatures will rise even more by the end of the twenty-first century and also the global mean sea levels are predicted to increase from 9 to 88 cm by the year 2100. These will be because of the thermal expansion of the oceans and the melting of glaciers and polar ice sheets. AQ: 1

Furthermore, the world is registering extreme weather conditions whereby there are more floods, severe droughts, dangerous cyclones and other natural calamities affecting the islands and other countries at large. The impacts of climate change on the tourism sector, particularly for island economies, are expected to be significant. A rise in sea level accompanied by beach erosion, degradation of coral reefs and loss of cultural heritage on the coasts through flooding will reduce the attractiveness of the small islands to tourists. Moreover, more intense cyclones and hurricanes will as well have negative impacts on the tourism sector. For example, in Barbados 70 per cent of the hotels are located within 250 m of the high-water mark. This suggests that many hotels are almost exclusively within the 100 inundation zones, placing them at risk of major structural damage (Marlene, 2002). Climate change can impact negatively on the amount of water available and increased danger of certain diseases. Such problems also discourage tourists from going to small islands. Moreover, the warm climatic condition in the northern countries could diminish the number of tourists visiting small islands in the tropical and subtropical regions preferring to shift to these northern countries. As a matter of fact, UNEP (1996) has posited that one of the most important assets of the island economies is reliable sunshine.

Empirical studies on the impact of climate change on tourism demand have been quite scant and to our knowledge nonexistent for the case of a sample of island economies. Such islands are mostly tourism dependent and they remain relatively more vulnerable to such climatic change given their characteristics. SIDS have different geographical and cultural factors, yet have similar economic and sustainable development challenges in terms of low availability of resources, a small but rapidly growing population, remoteness, susceptibility to natural disasters, excessive dependence on international trade and vulnerability to global developments.

Moreover, there is a warming of the ocean surface which has been detected around small island states and this problem is expected to continue. As a result of this warming, several problems can result such as an increase in heavy rainfall and other changes in precipitation patterns and intense or frequent cyclones/hurricanes. These climatic problems can lead to various adverse effects on the economy of the small islands in terms of negative influence on agricultural output, damaged coral reefs due to increased sea surface temperature and other potential damages such as water resources to be stressed by changes in precipitation patterns (Mimura *et al.*, 2007). Referring to the work of Braun *et al.* (1999), the environment is of utmost importance when tourists choose a holiday destination. There is substantial evidence showing that the world's climate will keep on changing in the future and upcoming deviations in temperature and other features linked with climate change such as precipitation will have various effects on different regions globally. It is probable that most of these direct effects of climate change, and their subsequent indirect effects, would have an impact on the island economies.

This paper thus explores the impact of climate change in the tourism sector by using a comprehensive data set comprising of 18[1] SIDS for the period from 1989 to 2016. This study uses a classical international tourism demand model, expanded to include two climatic variables, namely, temperature and precipitation (rainfall). This work also methodologically departs from most of the previous empirical studies on tourism modelling as it uses rigorous dynamic panel data analysis, namely, a panel vector autoregressive (PVAR) framework which also accounts for possible endogeneity issues in tourism modelling. In effect the PVAR model is of great importance in showing the dynamic behavior of economic time series and for forecasting. Also, it often provides better forecasts compared to those from uni- variate time series models and describe theory-based simultaneous equations models. The research is thus believed to supplement the existing literature on climate change and tourism by bringing new evidences from a panel set of island economies using a rigorous panel data econometrics framework.

The rest of the paper is organized as follows: Section 2 provides a review of the literature. Section 3 presents the model specification and data used. It also discusses the results from the empirical findings and section 4 provides the conclusion.

2. Related literature

Climate has been recognized to be crucial for tourists' decision-making and it as well impact on the successful operation of tourism businesses. For instance, there are forecasts that the surface and sea temperatures will rise, rain patterns will change, and there will be more extreme events. Hence tourism dependent islands need to know the impact of climate change in their regions as these will help them in their operations (Becken *et al.*, 2010).

In the literature, the concept of climate change and its impact on tourism has been sparingly discussed and most studies (see Eugenio-Martin, 2003, Song and Li, 2008 among others) relate either to the impact of tourism or to the classical determinants of tourism demand, with the climate change factor being largely under researched. Stern (2006) and Hamilton and Lau (2004) argued that climate change is nowadays an increasing concern, especially for the tourism sector, and it is important that such an element should be investigated, as it is an important resource for this sector. The authors posited that climatic factors that have the most impact on tourism are temperature, sunshine, radiation, precipitation, wind, humidity and fog. Such climate proxies are crucial and are believed to have serious impact on the tourism sector. As highlighted by Wall and Badke (1994), variations in climate also impact on various aspects of tourism operations such as water supply and quality, heating – cooling costs, snowmaking requirements, irrigation needs, pest management and evacuations and temporary closures. An international survey of 66 national tourism and meteorological organizations found that a large majority (81 per cent) felt weather and climate were major determinants of tourism in their nation. Burton (1995) and Boniface and Cooper (1994) argued that climate is among the most prevailing factors affecting global tourist flows.

Some studies on this topic include that of Koenig and Abegg (1997) who investigated the effect of climate change on tourism for the case of Switzerland. The analysis revealed that with prevailing temperature and a snow line of 1,200 m, there was an 85 per cent chance that there would be snow to keep the industry functioning. Nevertheless, if temperatures had to rise by 2°C, then only 65 per cent of all Swiss ski areas would be snow reliable. This would clearly have serious impacts for the growth of that sector of the industry. Regarding the temperature variable, some scholars have discussed that the rising temperature can affect the tourism industry positively as it can prolonged the warm season while others have discussed that rising temperature can affect the tourism industry negatively. For instance, Lise and Tol (2002) found that global warming would have devastating effect on the tourism industry. The authors conducted a cross section analysis on destinations of OECD tourists and used regression analysis on holiday activities of Dutch tourists to determine the best

temperatures at travel destination for different tourists and different tourist activities. It was found that OECD tourists prefer a temperature of 21 degree Celsius at their choice of destination. Hence, with global warming, tourists might shift their holiday destination.

Sookram (2009), on the other hand, confirmed a negative effect of both the temperature and precipitation variables on tourist arrivals for the case of a sample of Caribbean islands for the period from 1989 to 2007. Temperature is well thought out to be the vital climate variable in the examination of tourism demand because, it affects wellbeing and comfort. Apart from temperature there are other climate variables that can affect tourism like rain, wind and hours of sunshine as identified by Scott *et al.* (2006). The latter included both temperature and precipitation to examine tourism demand.

Using an autoregressive distributive lag approach, Durbarry and Seetanah (2015) analysed the dynamic relationship between tourism development and environmental degradation using time series data from the period from 1978 to 2011 for the case of Mauritius. Their results showed that tourism is related to increased CO_2 emissions and moreover, they reported that environmental degradation may be linked to reduced tourism arrival as well. Earlier econometric work by Nunes *et al.* (2013) for the case of the region of Tuscany, Italy, also confirmed similar findings. They reported a projected decrease in the annual tourism flows to the region of Tuscany (estimated between 13 per cent and 17 per cent by 2050). De Freitas (2003) investigated elements pertaining to weather forecasts and long-term expectations of climate, the risks to tourism caused by extreme atmospheric events, climate-related criteria and climate information on decisions about tourism and recreational choices. As per their study, a crucial "driver" of tourism climatology is the identification and evaluation of environmental information for business planning and decision-making in the recreation and tourism industry. Their studies incorporated data to proxy climate mainly to analyse what climate-related information are required by both tourists and the tourism industry.

Moreover, Scott and Lemieux (2010) discussed that all tourism destinations and operators are sensitive to climate and this has an impact on travel planning and travel experience. They observed that there are many foundations of climate information obtainable to the tourism sector and the continuing development of specialized climate products for tourists and tourism operators. It also revealed that there has been no systematic evaluation of the extent and nature of climate information use in any tourism subsector or specific destination region. Critically, the study concluded that climate change, particularly high emission scenarios, would be a pivotal issue affecting the medium- and long-term future of tourism development and management. Accordingly, it was recognized that the need for climate services would increase throughout the twenty-first century as the magnitude of climate change increases and the ability to rely on previous experience diminishes.

Another strand of the literature investigated the effects of climate change on tourist mobility in mountain areas, distinguishing between infrastructure, transport operation and travel demand. Cavallaro *et al.* (2017) for instance examined the change in tourist travel demand by proposing a two-step approach to forecast its future development. The results showed that average summer traffic could be more than twice as intense as average winter traffic, contributing to significantly increasing the peak days of congestion along the provincial road network. This fact would have an impact on tourism demand depending on climate. Wilkins *et al.* (2017) studied the varying perceptions and behavior of different tourist types, mainly with regards to their weather sensitivity, climate change concern and behavioral intention for climate change mitigation and reported that tourism demand may change with a changing climate, such as increased temperatures, precipitation and storms.

A summary of the existing literature tends to confirm that studies investigating the impact of climate change on tourism demand is relatively quite limited, particularly for the case of island economies. Moreover, existing literature have mainly overlooked the fact that the

hypothesized link may be examined in dynamic and endogenous setting for more analytical insights.

3. Methodology and analysis

The main purpose of this empirical work is to analyse the impact of climate change on tourist arrival in the short and long run for the case of a panel of 18 SIDS for the period from 1989 to 2016. Based on some recent studies such as Song and Witt (2000), Bigano *et al.* (2008) and Durbarry *et al.* (2009), Durbarry and Seetanah (2015) and Fauzel *et al.* (2016), an international tourism demand model is used to determine the variables that affect tourism demand in the SIDS countries. The tourism demand model is augmented by incorporating two climate variables, namely, temperature and precipitation (rainfall)[2]. The following conceptual form is thus used for this research:

$$\text{TOU} = f(\text{GDP, COST, WINC, TEM, RAIN})$$

where,

TOU is the total tourist arrivals in destination country is our measure of tourism development on the selected island, and the data are obtained from the World Tourism Organization Yearbook of Tourism Statistics, Compendium of Tourism Statistics and data files.

GDP is the real gross domestic product of the country and represent the level of development of the destination country, including tourism infrastructure.

Cost is the relative price movements in destination. In the present study it is constructed by using the CPI of a destination country adjusted by the dollar exchange rate (computed from indices extracted from the World Bank database) as a proxy for relative tourism prices[3]. Demand for overseas travel in a particular destination is expected to be negatively related to relative tourism prices as relatively higher cost of living would make most tourists less enthusiastic about the destination

WINC is the World GDP per capita and is a measure of the income capacity of the tourist, and the data are obtained from the CIA fact book.

TEM is the temperature level in the destination country and RAIN is the amount of rainfall (precipitation) in destination country (Sookram, 2009, Scott *et al.*, 2006). Both are our measures of climate change, and data are obtained from the World Bank database.

Because of the variance stabilizing properties of log transformation, the log values of the variables are used. In fact, logged variables ease the interpretation of the coefficients and make them readily comparable (in terms of percentage change).

Transforming all the variables in logarithmic terms yields:

$$\ln\text{TOU}_{\text{it}} = \alpha_0 + \beta_1 lnGDP_{it} + \beta_2 lnCOST_{it} + \beta_3 lnWINC_t + \beta_4 lnTEM_{it} + \beta_5 lnRAIN_{it} + \varepsilon_{it}$$

β_1 to β_5 represent the parameter estimates and ε_{it} is the random disturbance term.

3.1 Panel unit root testing and cointegration

Dealing with time varying data necessitate that our data series are stationary (that is with no unit root). Panel unit root tests are undertaken using the classical Im, Pesaran and Shin, ADF-Fisher, PP-Fisher and Levin, Lin and Chu tests. Results from these tests confirm that the variables follow an I(1) process. Subsequently, we test for the existence of a long-run equilibrium relationship between the variables. Indeed, non-stationary variables may deviate from each other in the short run, but the existence of co-integration will cause them to be associated in the long run, as they share the same stochastic trends. If the series are

co-integrated, the above equation will depict a long-run relationship. A heterogeneous panel co-integration test developed by Pedroni (1999) is used. The Pedroni panel co-integration test which is based on a residual-based ADF test validates the existence of a long-run co-integration relationship among the variables.

To account for dynamic and endogenous relationship in tourism modeling, this paper uses a PVAR approach to delineate the relationship between climate change and tourism development. Such an approach does not impose a priori restriction on the dynamic and endogenous relations among the different variables. It resembles a simultaneous equation modeling, whereby several endogenous variables are considered together. Moreover, in the presence of cointegration, this framework allows us to generate both short term and long-term associations between climatic change and tourism. The long-run coefficients from the cointegrating equation shows the long-run impact.

3.2 Empirical analysis and results

Table I below summarises the results from the long-run PVAR regression. T1

Table I is a composite table, where one can analyse each column which relates to an AQ: 2
equation (or gives an estimate of the coefficient of a model, with each independent coming AQ: 3
as the dependent variable in turn). An examination of the long-run results (refer to column 2, the tourism equation) indicates that the coefficient estimates are as expected and, more importantly, the results obtained for the climate variables are significant and show a negative impact on tourism. Hence, rising temperature and more rainfall both have inverse effects on tourist arrivals. This can be explained by the fact that small islands developing states face particular damage from global warming to storm surges, rising sea levels, beach erosion and coral bleaching which directly and indirectly affect tourism. Moreover, the small islands are susceptible to the impacts of climate change, which may be further affected if no proper action is taken. Also, another problem is that more extreme weather episodes lead to loss of life and damage to property and infrastructure that can certainly weaken small economies. Interestingly, it can further be noted that tourists prefer dry holiday locations rather than wet ones (Lise and Tol, 2002). Such results have important implications for tourist arrivals to island destinations due to the predicted increases in temperature. Comparing the two climate variables, it can be noted that the precipitation proxy affect tourism less than temperature.

It can be observed that an increase in the country's GDP has a positive effect on tourist arrivals. For instance, a 1 per cent increase in destination country's GDP leads to around 0.33 per cent increase in tourists' arrival. This may be explained by the fact that tourists are relatively sensitive to the economic environment and level of development, including tourism infrastructure, of the destination country. Cost, which is a measure of relative price movements in the origin and destination, shows a negative and significant coefficient implying that relatively higher cost of living would make most tourists less enthusiastic about

Table I Long-run estimates

	LTOU	*LRGDP*	*LWINC*	*LCOST*	*LRAIN*	*LTEM*
LTOU (−1)	0.386***	0.522**	0.00012*	0.234**	−0.145**	−0.183**
LRGDP (−1)	0.334**	0.743**	0.0007*	0.142***	−0.113**	−0145**
LWINC (−1)	0.765***	0.5543*	0.923***	6180E-05**	−0.083*	−0.14*
LCOST (−1)	−0.056**	−0.053*	−0.0001	0.921***	0.0422**	0.0002
LRAIN (−1)	−0.177**	−0.127*	−0.123	0.010	0.7134***	0.333*
LTEM (−1)	−0.134*	−0.248*	−0.146	0.4663	0.222*	0.926***
C	1.453	5.607	0.0662	−1.657	0.565	0.526
R-squared	0.77	0.53	0.64	0.71	0.74	0.6229

the destination. It is to be noted that the coefficient of this explanatory variable is quite small and this could be because most island economies still provides a still cheaper cost of living relative to the origin countries and also alternative tourist destinations.

Another important factor that influences tourist arrivals in our set of SIDS country is the income of the tourists as the higher their income, the higher will be demand for holiday travel. Our world GDP per capita proxy (WINC) is positive and significant confirming the fact that income of tourists (also a measure of capacity of pay) is one of the most influential elements (as judged by the coefficient obtained) in holidaying.

Interestingly, the significance of the lagged tourism variable validates the fact that tourism is a dynamic phenomenon. Further inferences can be made from the composite table above. For instance, referring to the sixth and seventh column, which can be read as the 'climate change' equations, it is observed that both proxies are also affected by tourism development confirming the presence of reverse causality in the climate change tourism nexus. Indeed, uncontrolled traditional tourism can pose various dangers to a lot of natural resources from across the globe. For instance, there may be significant problems that can damage the environment, such as natural habitat loss, increased pollution and CO_2 emission, soil erosion and more (Hanna and Oliva, 2015). Hence, we can conclude that an increase in tourism leads to environment degradation and vice versa. Moreover, an increase in economic growth leads to deterioration in this climate proxy (global warming). This result is in line with Grossman and Krueger (1995).

From the third column with real GDP as the dependent variable, we can observe that an increase in tourism leads to an increase in economic growth of those countries and this validates the tourism growth hypothesis. Finally, our result also supports the fact that environment degradation negatively impacts on the economic growth as judged by the negative and significant coefficient of the two proxies in the growth (GDP) equation.

3.3 Short-run estimates: the error correction model

As the series are co-integrated, an error correction model is subsequently used to determine the short-run effects. The short-run properties of the series are observed using a panel vector error correction model (PVECM), which is specified as follows:

$$\triangle(Z_{xt}) = \varphi + \rho \triangle (Z_{xt-1}) + \theta_{xt}$$

Where Δ The first difference operator, Z_{xt} represents a vector of the 6 variables used in this study, φ is a vector constant term, ρ symbolizes a (6 $\times$ 6) matrix of parameters, Zxt-1 is a vector of the 6 variables lagged by 1 and θ is the vector error term.

T2 The empirical results of the short-run estimates of the PVECM are displayed in the Table II.

The short-term results are overall in line with the long-run estimates obtained earlier, particularly with respect to our main climate variables which are reported to be negative and

Table II The short-run estimates

Error correction	*D(LTOU)*	*D(LRGDP)*	*D(LWINC)*	*D(LCOST)*	*D(LRAIN)*	*D(LTEM)*
ECM	−0.316***	−0.452**	−0.147**	-0.017***	-0.313**	-0.411
D(LTOU(−1))	0.152*	0.136*	0.0050	0.048*	0.015*	0.046*
D(LRGDP(−1))	0.121*	0.166*	0.001**	0.163**	0.035	0.055
D(LWINC(−1))	0.202*	0.150*	0.325*	0.146	−0.314	−0.0315
D(LCOST(−1))	−0.025	−0.151*	0.042	0.101**	0.0455	0.0042
D(LRAIN(−1))	−0.075*	−0.154	0.005	−0.011	0.3256*	−0.085**
D(LTEM(−1))	−0.096*	-0.174	0.091	−0.168	0.0605	0.256*
C	0.364**	−0.353	0.164**	0.636**	0.0554*	0.055**

significant as well. This confirms the fact that climate change also impacts on tourism in the short run, although with a lower incidence. The signs of the short-run dynamics are maintained for real GDP, world income and relative prices in the long run. The short-run estimates of the PVECM also allow us to make further analysis of the results.

A positive impact of tourism on economic growth is also noted and this is similar to the results uncovered in the long run confirming that tourism influences economic growth and the tourism led growth hypothesis in both the short run and long run. But it should be noted that tourism may as well put pressure on the environment, mainly when there is a huge number of visitors in regions where the resources are already inadequate. This is shown by the short-term coefficients of tourism development from both columns 6 and 7 above.

Finally, referring to column 2 above, the error correction term (ECM) is negative and significant implying that deviances from the long-run equilibrium will feed back on the changes in the dependent variables so as to force their movements towards the long-run equilibrium state. The coefficient shows the speed at which any disequilibrium is adjusted towards the long-run equilibrium.

4. Conclusions

It is undeniable that tourism is a crucial element of economic growth for SIDS. However, climate change can negatively impact on tourism demand, and thus, it leads to various negative effects on the economy of these countries mainly in terms of low growth rates and loss of employment. The purpose of this study was to estimate the impact of climate change on the tourism sector for a unique sample of 18 island economies for the period from 1989 to 2016 using a dynamic panel data technique, namely, a PVAR which also accounts for dynamic and endogeneity issues. The results from the analysis confirm the existence of a significant relationship between climate change and tourism demand in both the long and short run. Further analysis shows a bi-directional causality between climatic change and tourism demand. Tourism development might as well be a danger to a lot of natural resources from across the globe and can result in many problems that could completely damage the environment, such as natural habitat loss, increased pollution and CO_2 emission, soil erosion and more (Olivar, 2016). Finally, the study also confirms the tourism led growth hypothesis in both the long and short runs, while at the same time, there is evidence of repeat tourism for island economies.

Climate change will continue to affect the tourism sector in the coming years, especially for island economies. Hence, responses to climate change and sea-level rise should be coordinated and integrated with existing policies of socio-economic development and environmental conservation to facilitate sustainable development. Therefore, based on precautionary and anticipatory approaches, various strategies should be developed by researchers and policymakers to address the environmental issues as it has important social and economic impacts on SIDS. Few avenues that may necessitate considerations pertains to mitigation strategies such as incentives with respect to sustainable energy producing projects or adaptation strategies related to restoration of damaged coral reefs due to adverse climate change effects through coral nurseries, better reef monitoring to detect bleaching events, beach renourishment (as island economies are essentially beach destinations) and protection for hotels through flood drainage among others. Moreover, the fact that tourism development is also observed to have a negative effect on climate change reinforce the fact that the tourism and travel industry will have to adopt cleaner technologies to avoid climatic changes.

Notes

1. Antigua and Barbuda, Aruba, Barbados, Cape Verde, Comoros, Fiji, Grenada, Guyana, Jamaica, Maldives, Mauritius, Palau, Papua New Guinea, Solomon Islands, Suriname, Tonga, Trinidad and Tobago and Vanuatu.

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2. Warmer temperature means altered seasonality, heat stress for tourists, cooling costs, changes in: plant-wildlife-insect populations and distribution range, infectious disease ranges (Sookram, 2009).
3. The inverse of it shows the many baskets of goods a tourist has to sacrifice in his home country to buy a basket of goods in the destination country. This measure of relative prices captures changes in the real exchange rate over time as well as cross sectional variation in the cost of travel.

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