

**Tourism and economic growth: Multi-country evidence
from mixed-frequency Granger causality tests**

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journals.sagepub.com/home/teu**Martin Enilov** 

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Abstract

This article provides new global evidence for the causal relationship between international tourist arrivals (TA) and economic growth (EG). The analysis considers 23 developing and developed countries and covers the period from January 1981 to December 2017. The causal relationship between TA and EG is determined using a bootstrap mixed-frequency Granger causality approach adopting a rolling window technique to evaluate its stability and persistency over time. Empirical results show that causality is time-varying in both the short-term and the long-term. We illustrate our results by constructing a new global connectivity index (GCI). The GCI shows that international TA remain a leading indicator for future EG in a global perspective, especially during the global financial crisis (GFC). Our findings suggest that tourism sector plays an important part in the future EG in developing countries after the GFC. Similarly, the period after the GFC is characterised by one of the highest values of the tourism-led EG in developed countries according to the GCI; however, this effect is temporal and quickly eradicates. Overall, we find that tourism sector in developing countries remains a primary contributor to future EG, which is not the case in developed countries.

Keywords

bootstrap granger causality, economic growth, global tourism, mixed data sampling (MIDAS), rolling window

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Introduction

Tourism is one of the most visible and fastest growing facets of globalisation that has undergone remarkable growth over the last 50 years (Scott et al., 2019). Instead of shipping goods across space, tourism involves the export of non-tradable local amenities, such as beaches, mountains or cultural amenities, and local services, such as hotels, restaurants and local transport, by temporarily moving consumers across space (Faber and Gaubert, 2019). Worldwide, the international TA increased from 528 million in 2005 to 1.4 billion in 2018 (UNWTO, 2019). That not only increases foreign exchange income but also creates employment opportunities, stimulates the growth of the tourism industry and as a result of this, triggers overall EG (Lee and Chang, 2008). The estimates of the World Travel and Tourism Council (WTTC) reveal that the tourism sector accounted for 10.4% of global GDP and 319 million jobs in 2018 (WTO, 2018). With strong growth projections in international TA, the WTTC positions tourism as an important contributor to the United Nation's Sustainable Development Goals with forecasting the tourism sector to contribute 100 million new jobs globally over the next 10 years (UNWTO, 2019). In this context, we empirically investigate whether the tourism sector, represented by international TA, can be a leading indicator for future EG across 23 developing and developed nations, whether the stage of country development matters in this relationship, and by using time-varying models, to identify the periods of (dis)connect between tourism and EG.

Theoretically speaking, the tourism–growth relationship is rooted in international trade theories (Balassa, 1978; Krueger, 1980). The neoclassical trade theory emphasises the importance of international tourism to EG along the line of the law of comparative advantage such as the relative productive efficiency (the Ricardian model) and the relative abundance in factor endowments (the Heckscher–Ohlin model). Indeed, the product specialisation expands production possibility frontier and consumption, which further improves economic welfare. In particular, the tourism sector is a labour-intensive industry. International tourism expansion largely benefits developing nations that are less industrialised and with abundant labour receiving lower relative wages than their developed counterparts. Abundant cheap labour makes developing countries have comparative advantages on the international tourism industry relatively to capital abundant developed countries (Seyoum, 2007). In other words, the opportunity cost for developing countries to specialise in labour-intensive international tourism industry is lower than the developed countries. Further evidence that economic influences of tourism vary across countries is provided by Zhang and Jensen (2007) who argue that international tourists are attracted by natural endowments and/or cultural heritage in tourism destinations. This can be seen as comparative advantage of these destinations relative to the rest of the world along the lines of Heckscher–Ohlin model (Morley et al., 2014). According to the Ricardian model, it elucidates that the price of tourism product in home country to foreign countries differs due to the technology gap across countries (Ritchie and Crouch, 2003). The tourism destinations with relatively low cost of tourism product have competitive advantage in relation to other countries. This is particularly obvious in periods of financial turmoil when firms in the tourism and hospitality industry are able to lower their direct labour costs due to falling real wages. Therefore, the effects of financial crisis on tourism–growth linkage are likely to be asymmetrical with some destinations more exposed than others depending on their level of economic development.

Further to the above discussion, the link between international tourism and EG is subject to national and regional economic development stages (Brida et al., 2016; Cárdenas-García et al.,

2015; Hall, 2010; Lee and Chang, 2008; Lin et al., 2019; Smeral, 2003; Zuo and Huang, 2018, 2020). Smeral (2003) finds that tourism as an important component of leisure is considered to be a luxury good. However, most resources in developing countries are concentrated at providing normal goods, owing to low standard of living, in order to satisfy the basic human needs. As such, incomes from international tourism directly subsidise material livings in those countries and have a positive impact on EG and poverty reduction (Ashley and Mitchell, 2009). Some studies in the current tourism literature reveal that the impact of tourism on growth is disproportional with some groups of destinations being more dependent than others. Using a global sample of 144 countries, Cárdenas-García et al. (2015) prove that the tourism–growth relationship is different for countries at different development levels. The less developed countries are more likely to benefit from international tourism. In the same vein, Lin et al. (2019) find that the connection between tourism and EG is more likely to be observed in less-developed regions in China than their advanced counterparts. Therefore, the existing literature adds to our theoretical discussion that the link between tourism and EG depends on the level of economic development of a destination.

A large amount of literature has been devoted to address the question of whether there is a causal link between international tourism and EG. The predominant part of this literature has been confined to testing the direction of causality between the two variables which forms the following two hypotheses. The tourism-led EG (TLEG) hypothesis suggests that international tourism causes EG (Balaguer and Cantavella-Jorda, 2002; Lee and Chang, 2008; Tang and Abosedra, 2016; Tang and Tan, 2013, 2015). In fact, international tourism is one of the major contributors to EG through different channels. The tourism sector increases expenditures and/or incomes through generating foreign exchange earnings; leads to an upsurge in the domestic demand and hence production; enhances employment through new job creations; improves human capitals through education and on-the-job training; and fosters economic structural change and diversification (Antonakakis et al., 2019; Balaguer and Cantavella-Jorda, 2002; Cárdenas-García et al., 2015; Liu and Song, 2018; Ritchie and Crouch, 2003; Tribe, 2011). The economic-driven tourism growth (EDTG) hypothesis states that EG causes international tourism (Oh, 2005; Payne and Mervar, 2010; Tang and Jang, 2009). Eugenio-Martin et al. (2008) determine that local EG plays a vital role in promoting tourism development. For instance, EG improves the infrastructure and quality of services and then fosters tourism expansion. Also, Oh (2005) argues that fast EG boosts international trade and then attracts international arrivals. Antonakakis et al. (2015) conclude that EG enhances physical and human capital accumulations, which directly contributes to tourism growth. Concurrently, there are researchers who uphold the existence of bidirectional causality or no causal relationship at all (Antonakakis et al., 2015; Kim et al., 2006; Lean and Tang, 2010; Liu and Song, 2018; Mérida and Golpe, 2016). As can be noted, the findings provided by the existing literature about the tourism–growth causal link remain mixed, so general conclusion cannot be drawn about their interaction.

Given that the existing empirical work has largely concentrated on the analysis of tourism–growth relationship, the investigation of the relationship in a time-varying framework has been nearly ignored. The ignorance may be one of the reasons that led to conflicting results among past studies. Many past studies analyse the relationship between TA and EG in a time-invariant framework (see Balaguer and Cantavella-Jorda, 2002; Figini and Vici, 2010; Tang and Jang, 2009). However, Tang and Tan (2013) raise doubts about the stability of the tourism–growth relationship, showing that the connection varies over time in Asian economies. Hassani et al. (2017) also argue that the tourism–growth relationship is not stable over time, providing evidence

of parameter instability in the case of European countries. Moreover, Wan and Song (2018) highlight that various time horizons are relevant to decision-making in the tourism sector. Specifically, Hassani et al. (2017) acclaim that short-term forecasts are required for scheduling and staffing, while long-term forecasts for investment in aircraft, hotels and infrastructure. To address the time changing patterns in the relationship between international TA and EG, our study presents two sets of results, one is based on full-sample estimation, and the other one adopts time-varying estimation techniques.

Most existing empirical studies in the tourism–growth literature aggregate high-frequency tourism data into lower frequency in order to fit the requirements of the classical same-frequency models (Kim et al., 2006). However, international TA is a floating variable and by aggregating a predictor variable into a lower frequency may conceal important predictive information. Therefore, we use the mixed-frequency VAR (MF-VAR) approach of Ghysels et al. (2016) to congenialise different frequency variables within the same empirical model so as to overcome the temporal aggregation bias (see Bevilacqua et al., 2019; Boffelli et al., 2016; Ferrara and Guérin, 2018; Ghysels, 2016). To address the time-variability patterns, we extend the full-sample approach of Ghysels et al. (2016) to a time-varying MF-VAR framework by using a rolling window method. This method is relatively robust to the presence of time-varying parameters and does not require imposing assumptions regarding the nature of time variation in the data (Chen et al., 2010).

This study contributes to the existing literature from various aspects. First, we draw a firm conclusion on the leading indicator power of international TA for predicting EG in developed and developing economies across Americas, Asia, Europe and Oceania. Second, we systematically investigate the causality of tourism–growth relationship for each individual country by using a cutting-edge methodology that allows us to combine variables in different frequency within the same estimation model, that is, MF-VAR. Third, we identify the existing temporal evidence for the tourism sector being a leading indicator of EG in a global perspective. To conduct this analysis, we implement a bootstrap time-varying MF causality approach. Last but not least, we construct a new index of global connectivity index (GCI) that graphically represents the periods of strong and weak connections between international TA and EG across the globe. We find that our results persist subject to several robustness checks.

The rest of this article is organised as follows. The ‘Econometric methods’ section briefly discusses the MF-VAR procedure and the construction of the GCI. The ‘Data’ section describes the data sources and provides some preliminary statistics. Next, the estimation results and empirical analysis are presented. The ‘Robustness check’ section examines the persistency of our results. The last section concludes this article.

Econometric methods

In this article, we investigate the relationship between monthly TA (TA) and quarterly real GDP growth (EG) by using the MF-VAR approach proposed by Ghysels et al. (2016). $\tau \in \{1, 2, \dots, T_L\}$ is a time sequence at quarterly frequency. $TA(\tau, j)$ denotes the series of TA at the j th month of quarter τ , where $j \in \{1, 2, 3\}$. $EG(\tau)$ represents the series of EG at quarter τ . The MF-VAR model is specified as follows

$$\underbrace{\begin{bmatrix} \text{TA}_{(\tau,1)} \\ \text{TA}_{(\tau,2)} \\ \text{TA}_{(\tau,3)} \\ \text{EG}_{(\tau)} \end{bmatrix}}_{\equiv X_{(\tau)}} = \sum_{k=1}^p \underbrace{\begin{bmatrix} a_{11,k} & a_{12,k} & a_{13,k} & a_{14,k} \\ a_{21,k} & a_{22,k} & a_{23,k} & a_{24,k} \\ a_{31,k} & a_{32,k} & a_{33,k} & a_{34,k} \\ a_{41,k} & a_{42,k} & a_{43,k} & a_{44,k} \end{bmatrix}}_{\equiv A_k} \underbrace{\begin{bmatrix} \text{TA}_{(\tau-k,1)} \\ \text{TA}_{(\tau-k,2)} \\ \text{TA}_{(\tau-k,3)} \\ \text{EG}_{(\tau-k)} \end{bmatrix}}_{\equiv X_{(\tau-k)}} + \underbrace{\begin{bmatrix} \varepsilon_{(\tau,1)} \\ \varepsilon_{(\tau,2)} \\ \varepsilon_{(\tau,3)} \\ \varepsilon_{(\tau,4)} \end{bmatrix}}_{\equiv \varepsilon_{(\tau)}} \quad (1)$$

where A_k is a coefficient square matrix for $k = 1, \dots, p$. p is the lag length, which is selected using the Bayesian information criterion (BIC). $\varepsilon_{(\tau)}$ is the vector of error terms. In line with Ghysels et al. (2016), the constant term is not included in equation (1).¹ Therefore, $X_{(\tau)}$ should be considered as a demeaned process. Equation (1) can then be rewritten as

$$X_{(\tau)} = \sum_{k=1}^p A_k X_{(\tau-k)} + \varepsilon_{(\tau)} \quad (2)$$

To ensure the consistency and asymptotic normality of the least squares estimator \hat{A}_k , the following assumptions are made in alignment with Ghysels et al. (2016). First, all roots of the polynomial $\det(I_4 - \sum_{k=1}^p A_k z^k) = 0$ lie outside the unit circle. This ensures that the MF-VAR is state stationary. Second, $\varepsilon_{(\tau)}$ is a strictly stationary martingale difference sequence with a finite second moment. Third, $\{X_{(\tau)}, \varepsilon_{(\tau)}\}$ obeys α -mixing process, which is a standard assumption to ensure the validity of the bootstrap for VAR models (see Cavaliere et al., 2012).

We iterate equation (2) over the desired test horizon h and lag order p in order to investigate the long-horizon Granger causal relationship between TA and EG. The MF-VAR(p, h) model is as follows

$$X_{(\tau+h)} = \sum_{k=1}^p A_k^{(h)} X_{(\tau+1-k)} + u_{(\tau)}^{(h)} \quad (3)$$

where $u_{(\tau)}^{(h)} = \sum_{k=0}^{h-1} \Psi_k \varepsilon_{(\tau-k)}$, Ψ_k is a vector of coefficients.

Next, we outline the procedure for performing the Granger causality test based on Wald statistics, where $B(h) = [A_1^{(h)}, \dots, A_p^{(h)}]'$ is a set of the MF-VAR(p, h) coefficients. Based on equation (1), the null hypothesis that TA do not Granger-cause EG is equal to $a_{41,1} = \dots = a_{42,1} = \dots = a_{43,p} = 0_{1 \times 3p}$, whereas the null hypothesis that EG does not Granger-cause TA is set equal to $a_{14,1} = \dots = a_{24,1} = \dots = a_{34,p} = 0_{3p \times 1}$. Overall, the null hypothesis of non-causality is defined as

$$H_0(h) : R \text{vec}[B(h)] = r \quad (4)$$

where R is a $q \times pk^2$ matrix of full row rank q , and r is a restricted vector of zeros (Ghysels, 2016). Thus, the null hypothesis of the MF Granger causality test is expressed using Wald statistic

$$W_{T_L^*}[H_0(h)] \equiv T_L^* (R \text{vec}[\hat{B}(h)] - r)' \times \left(R \sum_p \hat{\Sigma}(h) R' \right)^{-1} \times (R \text{vec}[\hat{B}(h)] - r) \quad (5)$$

where $T_L^* \equiv T_L - h + 1$ is the effective sample size, $\hat{B}(h)$ is the least square estimator and $W_{T_L^*}[H_0(h)] \rightarrow \chi_q^2$ under $H_0(h)$.

To circumvent the size distortions for small samples, we adopt the recursive parametric wild bootstrap approach proposed by Gonçalves and Kilian (2004). Their bootstrap procedure does not require knowledge of the true distribution of the error term and is robust to conditional heteroskedasticity of unknown form. As such, the Wald statistic p values are computed based on the Gonçalves and Kilian's (2004) wild bootstrap with $N = 999$ replications.² The resulting Wald statistic p values of equation (5) are

$$\hat{p}_N(W_{T_L^*}[H_0(h)]) = \frac{1}{N+1} \times \left(1 + \sum_{i=1}^N I(W_i[H_0(h)] \geq W_{T_L^*}[H_0(h)]) \right) \quad (6)$$

where $W_i[H_0(h)]$ is the Wald test statistic based on the i th simulation sample and the null hypothesis $H_0(h)$ is rejected at significance level α if $\hat{p}_N(W_{T_L^*}[H_0(h)]) \leq \alpha$ (Ghysels et al., 2016).

We extend our analysis to a time-varying framework in order to account for potential structural changes in the tourism–growth relationship by using a rolling, rather than a recursive, window estimation as it adapts more quickly to possible structural changes (see Antonakakis et al., 2015; Arslanturk et al., 2011; Liu and Song, 2018; Tang and Abosedra, 2016). In fact, the rolling procedure is relatively robust to the presence of time-varying parameters and requires no explicit assumption as to the nature of time variation in the data. The rolling window size of 40 quarters is used for estimating the model parameters.

Last but not least, we construct a new index of GCI that graphically represents the periods of strong and weak connections between international TA and EG around the world. The GCI is based on the results from the time-varying MF estimations at the horizon of one quarter. Specifically, for each rolling window time period, t^* , we identify whether a causal link is established or not for each country. The causal link is defined as *established* if the null hypothesis of non-causality is rejected at the 10% level of significance. Following Billio et al. (2012), the GCI is calculated by working out the total number of *established* causal links, n_{t^*} , dividing it by the total number of all possible causal links, N_{t^*} , in a given time period t^* and then multiplying by 100. The index value ranges between 0 and 100. The formula of GCI is

$$\text{GCI} = \frac{n_{t^*}}{N_{t^*}} \times 100 \quad (7)$$

Based on equation (7), we construct two separate GCIs: TLEG GCI and EDTG GCI. The TLEG GCI is based on the results from testing the null hypothesis $H_0 : \text{TA} \not\Rightarrow \text{EG}$, whereas the EDTG GCI is formulated on the results from testing the null hypothesis $H_0 : \text{EG} \not\Rightarrow \text{TA}$. The TLEG GCI displays the periods of (dis)connect from international TA to EG. For example, if the value of the TLEG GCI is close to 100, then EG in a greater number of countries is dependent on international TA, whereas if the TLEG GCI is close to 0, then the EG in very few countries is dependent on international TA. The definition and interpretation of the EDTG GCI are analogous.

Data

Data source

This article uses a mixture of annual log differenced data of monthly international TA and quarterly real GDP per capita. The data set includes 23 countries, out of which are 9 of the top 10 most popular destinations that were visited by international TA in 2018 (WTO, 2018). The period of investigation spans from January 1981 to December 2017.³ Following others (see Bokelmann

and Lessmann, 2019; Dergiades et al., 2018; Liu and Song, 2018; Tang and Abosedra, 2016), we use international TA as a proxy for tourism demand. The series of international TA are collected from the CEIC Global Database (CEIC, 2018). The real GDP per capita series are used for calculating EG and are obtained from Datastream.

Time series properties

The standard parametric models rely on assumptions such as normality which is likely to be violated in almost all series considered here (see the Online Appendix, Table A.1). However, the asymptotic theory of MF-VAR models does not require the normality assumption, which is another benefit of using MF-VAR modelling within our empirical framework.

Before we start our analysis of causality, we employ unit root tests to check the stationarity of our data series. Table 1 presents the results from testing the null hypothesis of a unit root for EG (EG) and TA (TA) series. The unit root test that we used is the popular augmented Dickey–Fuller (ADF) test (Dickey and Fuller, 1979) including an intercept. The test statistic and the p -value are reported for each series. The estimated lag length for each series is obtained by using the BIC. According to the ADF test, the unit root null hypothesis cannot be rejected for EG series in 12 countries (Australia, Bulgaria, China, Finland, Hungary, India, Italy, Japan, Philippines, South Korea, Spain and the United Kingdom). For the rest of the countries, EG is found to be stationary. For the TA, the ADF test results suggest that the unit root null hypothesis is rejected for all but three countries (Indonesia, Japan and the United States).

The ADF unit root tests do not take account of the presence of structural breaks in the data but if structural breaks are present in the data, such conventional unit root tests have low power and can give misleading conclusions (Perron, 1989). We have therefore made use of the Fourier ADF unit root test proposed by Enders and Lee (2012) which allows for an unknown number of level breaks. The Fourier ADF test has a null hypothesis of a unit root series with the unknown number of level breaks, while the alternative hypothesis is of the stationary process with the unknown number of level breaks. The lag length is selected by using the BIC. What we notice in Table 1 is that for all series for which the null cannot be rejected by the ADF unit root tests, the Fourier ADF unit root tests suggest stationarity. We therefore proceed as if all data series are in fact unit root stationary.

Empirical analysis

The outcomes of the empirical analysis are presented in three steps. We begin by providing the results from the full sample MF estimation. Then, the study considers the possible instability in the tourism–growth relationship so that the results from the time-varying MF estimation are obtained. Finally, we provide a graphical representation of a chronological sequence of the periods of (dis)connect between international TA and EG.

Full sample estimation results

To begin with, we present the results from the full sample MF estimation. We investigate the TLEG hypothesis by testing the null hypothesis $H_0 : TA \not\Rightarrow EG$. The rejection of the null hypothesis implies that TA cause EG. Analogously, we examine the validity of the EDTG hypothesis by testing the null hypothesis $H_0 : EG \not\Rightarrow TA$. The lag order is selected by using the BIC. To investigate how far in future the predictor variable can predict the variable of interest, we

Table 1. Unit root test results.

Country	Economic growth		Tourism arrivals: mixed-frequency					
	ADF with intercept	Fourier ADF with intercept	ADF with intercept			Fourier ADF with intercept		
			TA ($\tau, 1$)	TA ($\tau, 2$)	TA ($\tau, 3$)	TA ($\tau, 1$)	TA ($\tau, 2$)	TA ($\tau, 3$)
Australia	-2.250	-6.171***	-3.437**	-4.106***	-3.188**	-4.109**	-4.202**	-6.423***
Austria	-3.682***	-4.470***	-6.610***	-5.589***	-3.966***	-7.160***	-5.903***	-7.427***
Bulgaria	-2.208	-3.733*	-5.531***	-6.073***	-4.826***	-6.408***	-7.074***	-3.713***
Canada	-2.629*	-3.467**	-3.030**	-7.986***	-7.180***	-4.304***	-8.382***	-7.428***
China	-2.066	-4.303**	-3.087**	-4.845***	-3.903***	-5.658***	-6.464***	-4.227***
Finland	-2.024	-4.927***	-5.699***	-4.578***	-4.638***	-7.103***	-5.442***	-4.737***
Germany	-3.826***	-5.897***	-4.857***	-4.040***	-5.044***	-6.345***	-6.350***	-6.968***
Greece	-3.250**	-3.368	-4.663***	-3.336**	-4.306***	-3.919**	-3.519**	-4.116**
Hungary	-2.281	-3.688*	-4.666***	-5.567***	-4.183***	-4.486***	-4.828***	-4.362***
India	-2.290	-4.563***	-4.306***	-6.381***	-3.851***	-7.412***	-7.103***	-6.392***
Indonesia	-2.736*	-4.887***	-3.040**	-1.835	-5.668***	-3.797*	-5.302***	-6.448***
Italy	-1.936	-5.379***	-3.570***	-4.029***	-4.504***	-7.373***	-4.333***	-7.286***
Japan	-2.285	-2.929*	-4.247***	-2.262	-4.072***	-4.860***	-5.523***	-4.498***
Malaysia	-2.632*	-4.990***	-4.724***	-3.979***	-5.906***	-3.794***	-4.121***	-3.960***
Mexico	-4.223***	-7.033***	-4.534***	-7.531***	-8.329***	-5.395***	-7.911***	-8.510***
Netherlands	-2.641*	-4.835***	-5.828***	-5.966***	-2.752*	-6.246***	-6.274***	-3.855***
New Zealand	-3.877***	-5.594***	-3.719***	-4.235***	-5.877***	-6.768***	-4.725***	-5.069***
Philippines	-2.369	-4.461***	-5.888***	-4.083***	-6.186***	-3.392**	-4.999***	-5.467***
South Korea	-1.873	-4.260**	-3.184**	-4.876***	-5.270***	-11.189***	-5.242***	-6.002***
Spain	-1.562	-4.046**	-3.906***	-4.663***	-5.432***	-5.092***	-5.487***	-5.970***
Switzerland	-4.950***	-3.505**	-4.638***	-4.304***	-4.688***	-5.327***	-4.824***	-5.004***
United Kingdom	-2.416	-2.952*	-4.618***	-4.077***	-4.307***	-6.032***	-4.764***	-8.972***
United States	-2.839*	-3.237**	-4.892***	-4.635***	-2.136	-5.436***	-5.187***	-3.589**

Note: ADF: augmented Dickey-Fuller. The table reports the test statistics obtained from the unit root tests.

*Statistical significance at the 10% level.

**Statistical significance at the 5% level.

***Statistical significance at the 1% level.

use different time horizons (h), where h represents the number of quarters. For simplicity, we define a short-term ($h = 1$) to be the one where the predictor variable has an immediate effect over the variable of interest, whereas the long-term ($h \in \{2, 3, 4, 6\}$) is the one where the predictor variable can forecast the variable of interest few quarters ahead. The results from the full sample Granger causality tests are reported in Table 2.

Table 2 reports the bootstrapped p values for the full sample MF Granger causality tests. The test results suggest little evidence of predictability from tourism development to EG at a 10% level of significance. In fact, the short-term TLEG hypothesis is supported for few developed and developing countries (eight in total), while evidence for long-term TLEG hypothesis is for even fewer economies (six in total). The short-term evidence suggests that TA have an immediate impact only in developing economies within Asia, while for developing countries outside Asia, the impact of tourism on EG has some lagged effect. The evidence for developed economies is rather mixed. In contrast, the concept of EDTG receives weak support. In particular, the short-term EDTG hypothesis receives support only in large developing economies, such as China and India. In contrast, EG in neither of the developed countries is found to have a short-term impact on international TA. The evidence for long-term EDTG hypothesis remains mixed.

The merits of international TA on EG in developing countries can be further explained through three round effects. First, an increase in the demand for international TA in developing economies triggers expansion of the hospitality industry including some construction works that contribute directly to EG as a first-round effect. Moreover, the expansion of the hospitality industry absorbs abundant labour from the rural agricultural sector by providing job opportunities and experiences of urban life, which further contributes to EG as a second-round effect. This fits to the concept of shifting surplus labour from the rural agricultural sector to urban industrial sector implied in the dual-sector Lewis (1954) model (see also Sahli and Nowak, 2007; Zuo and Huang, 2020). In a nutshell, our findings for the tight causal relationship from international tourism arrivals to EG in developing nations lie within the theoretical concept that the expansion of the service sector in developing countries speeds up the economic structural change and further encourages urbanisation and economic diversification, which creates additional dividends for EG as a third-round effect.

Moreover, we conclude that TA have a prompt impact on EG in developing countries, in particular, in Asia. This finding is consistent with the discussion made previously in the introduction regarding the impact of tourism expansion on growth in developing countries. In particular, we find that EG in large developing countries, China and India, is a leading factor for international TA in short-term. On the side of large developing countries, this result can be explained attributable to the recent massive investments of these economies into infrastructural projects such as construction of new airports and high-speed railways that directly contribute to EG and make these destinations more accessible for foreign travellers. This is consistent with Lin et al. (2019) who claim that the EDTG is more likely to appear at less developed regions with bigger size of the economy. Despite these findings, the long-term evidence remains inconclusive.

With respect to developed countries, we find a lesser impact of international TA on EG. This is in line with the study of Smeral (2003), who argues that tourism in industrialised countries faces higher costs and price disadvantages than developing countries. Also, our findings are consistent with the six key phases of the tourism life cycle path by Moore and Whitehall (2005), namely exploration, involvement, development, consolidation, stagnation, decline and/or rejuvenation. Precisely, developed countries are at the late stage of tourism life cycle path as they have been attracting international tourists for long and the tourism industry is more mature compared to developing

Table 2. Bootstrapped p values from full sample MF tests.

Country	h = 1			h = 2			h = 3			h = 4			h = 6				
	TA	EG	TA	EG	TA	EG	TA	EG	TA	EG	TA	EG	TA	EG	TA	EG	TA
Developing countries																	
China	0.555	0.081	0.591	0.164	0.680	0.240	0.714	0.130	0.826	0.812							
India	0.079	0.077	0.099	0.343	0.122	0.360	0.314	0.034	0.622	0.220							
Indonesia	0.254	0.407	0.191	0.772	0.080	0.946	0.065	0.605	0.492	0.868							
Malaysia	0.006	0.639	0.057	0.463	0.535	0.164	0.871	0.300	0.921	0.099							
Mexico	0.213	0.548	0.548	0.605	0.596	0.256	0.285	0.050	0.082	0.724							
Philippines	0.022	0.969	0.237	0.805	0.588	0.681	0.609	0.569	0.543	0.555							
South Korea	0.112	0.483	0.331	0.677	0.719	0.651	0.972	0.828	0.196	0.661							
Developed countries																	
Australia	0.021	0.752	0.099	0.690	0.222	0.674	0.330	0.782	0.099	0.878							
Austria	0.721	0.133	0.753	0.744	0.506	0.878	0.338	0.278	0.269	0.341							
Bulgaria	0.784	0.443	0.674	0.485	0.822	0.183	0.652	0.801	0.786	0.667							
Canada	0.493	0.696	0.758	0.555	0.611	0.369	0.703	0.203	0.456	0.333							
Finland	0.506	0.276	0.286	0.045	0.113	0.025	0.062	0.178	0.013	0.992							
Germany	0.642	0.401	0.310	0.296	0.278	0.243	0.300	0.032	0.029	0.064							
Greece	0.490	0.736	0.714	0.312	0.826	0.578	0.841	0.750	0.795	0.431							
Hungary	0.622	0.156	0.746	0.217	0.831	0.488	0.911	0.867	0.996	0.197							
Italy	0.084	0.814	0.309	0.714	0.177	0.571	0.206	0.713	0.133	0.944							
Japan	0.281	0.801	0.466	0.499	0.680	0.095	0.438	0.624	0.249	0.501							
Netherlands	0.235	0.341	0.175	0.801	0.167	0.959	0.259	0.995	0.590	0.900							
New Zealand	0.044	0.896	0.255	0.716	0.840	0.953	0.687	0.722	0.369	0.276							
Spain	0.332	0.263	0.243	0.656	0.414	0.946	0.514	0.748	0.480	0.465							
Switzerland	0.037	0.694	0.155	0.981	0.294	0.881	0.407	0.848	0.572	0.123							
United Kingdom	0.409	0.281	0.653	0.188	0.748	0.198	0.817	0.293	0.989	0.762							
United States	0.042	0.559	0.862	0.398	0.837	0.940	0.863	0.928	0.278	0.562							

Note: MF: mixed-frequency. Bold numbers indicate the rejections at a 10% significance level. h denotes the time horizon. The null hypothesis is specified as $H_0 : TA \neq EG$ (\neq means 'does not Granger-cause'). Analogously, $H_0 : EG \neq TA$ is defined.

economies. Indeed, developed economies are more likely of being at stagnation, decline and/or rejuvenation stages, whereas developing countries are at involvement and development stages. However, the full sample results presented in Table 2 do not consider the fact that in the relationship between international TA and EG, there may be a mixture of periods of both causality and non-causality. Accounting for this, we take this into consideration by using a time-varying approach and present the results in the next section.

Time-varying estimation results

Here, we present the results for time-varying predictability. The principal reason for adopting this approach is the evidence in the existing literature that the relationship between inbound tourism and EG varies over time (see Arslanturk et al., 2011; Liu and Song, 2018; Tang and Tan, 2013). More specifically, the stability of the tourism–growth relationship may be affected by news related to national security, such as civil war, terrorism and political instability (see Araña and León, 2008; Blake and Sinclair, 2003; Saha and Yap, 2014; Saha et al., 2017; Sönmez, 1998). Therefore, the rolling window approach is undertaken to determine the existence of temporal relationship between TA and EG. The size of the rolling window is 40 quarters ($rw = 40$), while the lag number is selected by using the BIC.

Table 3 reports the rejection frequencies for the time-varying MF Granger causality tests. The null hypothesis of non-causality is specified for each rolling window. The rejection frequency is calculated as the total number of p values significant at 10% level is divided by the total number of rolling window tests. For instance, the rejection frequency for testing the null hypothesis that TA do not Granger-cause EG ($H_0 : TA \not\Rightarrow EG$) for China is 0.143 at $h = 1$. This implies that 14.3% of all p values are significant at 10% level. This contrasts to the full sample results that reveal no evidence of causality from TA to EG in China. This example highlights the plausibility of adopting time-varying methods, together with our full sample analysis, in a way to determine causal patterns in an environment driven by structural changes.

With this intention, we first discuss the results from the EDTG hypothesis which suggest that EG is an important predictor for future international TA across numerous countries (see Table 3). In particular, we find that EG has short-term predictive power for international TA in all countries except China, Greece, Hungary and Spain. Similarly, the long-term EDTG hypothesis is supported for almost all countries except Bulgaria, China, Greece and Hungary. Nonetheless, the EDTG hypothesis seems to occur in both developing and developed countries, which is consistent with the recent work of Antonakakis et al. (2019).

Next, we identify the existence of short-term TLEG for all countries but Bulgaria. This finding suggests that, even transitory, the tourism sector has been a driving force for future EG in short-term for both developing and developed economies. Further, the long-term TLEG hypothesis is supported in a broad set of countries. The only countries where time-varying TLEG causality is not evident are some developed nations in Americas and Europe, including Austria, Bulgaria, Hungary, Italy and the United States. This finding leads to the following conclusions. First, international TA are a short-term leading indicator for EG in both developing and developed economies. Second, EG in developed countries is less affected by the long-term fluctuations in tourism demand, represented by international TA. Third, international TA are a substantial driver for future EG in developing economies. Overall, our study provides solid support for the TLEG hypothesis in both developing and developed countries. This finding emphasises that the tourism sector is today

Table 3. Rejection frequencies from time-varying MF tests.

Country	h = 1			h = 2			h = 3			h = 4			h = 6		
	TA	EG	TA	TA	EG	TA	TA	EG	TA	TA	EG	TA	TA	EG	TA
Developing countries															
China	0.143	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.095	0.000	0.000	0.048	0.000	0.000
India	0.175	0.488	0.150	0.588	0.075	0.288	0.075	0.288	0.050	0.050	0.213	0.000	0.000	0.000	0.100
Indonesia	0.284	0.037	0.147	0.018	0.055	0.064	0.055	0.064	0.083	0.083	0.046	0.000	0.083	0.000	0.000
Malaysia	0.740	0.288	0.466	0.219	0.000	0.356	0.000	0.356	0.000	0.000	0.096	0.000	0.014	0.425	0.000
Mexico	0.046	0.202	0.000	0.202	0.000	0.073	0.000	0.073	0.018	0.018	0.018	0.000	0.028	0.028	0.000
Philippines	0.273	0.221	0.117	0.156	0.039	0.039	0.039	0.039	0.039	0.039	0.013	0.000	0.000	0.195	0.000
South Korea	0.284	0.275	0.193	0.037	0.018	0.009	0.018	0.009	0.000	0.000	0.009	0.000	0.055	0.211	0.000
Developed countries															
Australia	0.541	0.211	0.257	0.220	0.239	0.211	0.239	0.211	0.220	0.220	0.009	0.000	0.257	0.028	0.000
Austria	0.103	0.724	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.034	0.000
Bulgaria	0.000	0.143	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Canada	0.046	0.229	0.000	0.303	0.037	0.138	0.037	0.138	0.064	0.064	0.064	0.000	0.046	0.092	0.000
Finland	0.061	0.020	0.000	0.000	0.000	0.327	0.000	0.327	0.000	0.000	0.020	0.000	0.041	0.000	0.000
Germany	0.492	0.066	0.393	0.082	0.377	0.180	0.377	0.180	0.410	0.410	0.361	0.000	0.443	0.377	0.000
Greece	0.455	0.000	0.182	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Hungary	0.167	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Italy	0.014	0.072	0.000	0.043	0.000	0.058	0.000	0.058	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Japan	0.147	0.064	0.009	0.046	0.000	0.018	0.000	0.018	0.009	0.009	0.009	0.000	0.018	0.000	0.000
Netherlands	0.391	0.072	0.159	0.261	0.014	0.290	0.014	0.290	0.029	0.029	0.000	0.000	0.014	0.000	0.000
New Zealand	0.119	0.413	0.037	0.229	0.018	0.220	0.018	0.220	0.009	0.009	0.156	0.000	0.009	0.092	0.000
Spain	0.306	0.000	0.041	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.102	0.000
Switzerland	0.514	0.270	0.108	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.081	0.000
United Kingdom	0.083	0.064	0.055	0.000	0.028	0.009	0.028	0.009	0.037	0.037	0.000	0.000	0.055	0.009	0.000
United States	0.432	0.091	0.000	0.114	0.000	0.045	0.000	0.045	0.000	0.000	0.045	0.000	0.000	0.000	0.000

Note: MF: mixed-frequency. h denotes the time horizon. The null hypothesis is specified as H_0 : TA \nRightarrow EG (\nRightarrow means 'does not Granger-cause'). Analogously, H_0 : EG \nRightarrow TA is defined.

one of the most powerful global drivers of EG in both short-term and long-term (see, e.g. Liu and Song, 2018, for Hong Kong).

Although, the time-varying evidence determines that international tourism has impact on EG in numerous countries, the underlying periods of (dis)connect between TA and EG are not defined. Identifying these periods has important policy implications, so that EG can be leveraged more by international tourism arrivals. To reflect this, the next section considers the outcomes from the time-varying tests and presents a new global index of time-varying connectivity between TA and EG.

Global connectivity index

An important question that remains unanswered in many past studies is what the periods of strong and weak connections between international TA and EG in a global perspective. Thus, we construct separate GCIs in terms of developing, developed and all countries. For each group of countries, the GCIs are calculated in case of both TLEG GCI and EDTG GCI hypotheses. We consider the period of January 1996–December 2017 for constructing our indexes, while the following 16 countries are included: Australia, Canada, Finland, Germany, India, Indonesia, Italy, Japan, Malaysia, Mexico, Netherlands, New Zealand, Philippines, South Korea, Spain and the United Kingdom. The restriction in the time period and country selection is required in order to create an index build on the balanced data set that allows comparison of results over time. By doing so, we show a graphical representation of the periods of (dis)connect between TA and EG.

Figure 1 presents the GCI in terms of all countries. It highlights the following key findings. On the one side, EG has become a less influential factor for future TA in the past few years. A possible explanation of this finding is the rapid tourism product development and assembly in destinations based on the degree of intensification and of concentration and diversification of tourism products (see Benur and Bramwell, 2015). Therefore, EG of a country has turned into a less significant factor in attracting tourists from abroad. On the other side, international TA remain a leading indicator for future EG in a global perspective. Also, we observe that larger number of countries show evidence that TA influence their EG during a crisis period than otherwise, especially during the global financial crisis (GFC). The economic intuition behind this relies on the fact that during a financial turmoil an increase in international tourism inflows injects money into the circular flow of income. This plays a more substantial role than in non-crisis years as it can bring temporary job opportunities, which helps to alleviate high unemployment pressures on central and local governments during the crisis. The effects of the financial crises on tourism are likely to be asymmetrical with some destinations more exposed than others. Even under normal circumstances, some destinations tend to be disproportionately vulnerable to the effects of such crises due to their high reliance on the tourism sector (OECD, 2020). This disparity is likely to be significantly exacerbated following the crisis. To investigate whether economic influences of tourism vary across countries, we split our sample of countries into two groups based on the level of economic development of a destination.

To examine whether the stage of economic development matters for the tourism–growth relationship, we use two GCIs for developing and developed countries that are presented in Figures 2 and 3, respectively.

Figure 2 suggests that tourism sector plays an important part for future EG in developing economies by increasing its role after the GFC. In fact, after the GFC, we notice that international TA keep their position as a leading indicator of EG in developing economies. This finding corresponds to the Lewis (1954) model who suggests that the core of economic development is to

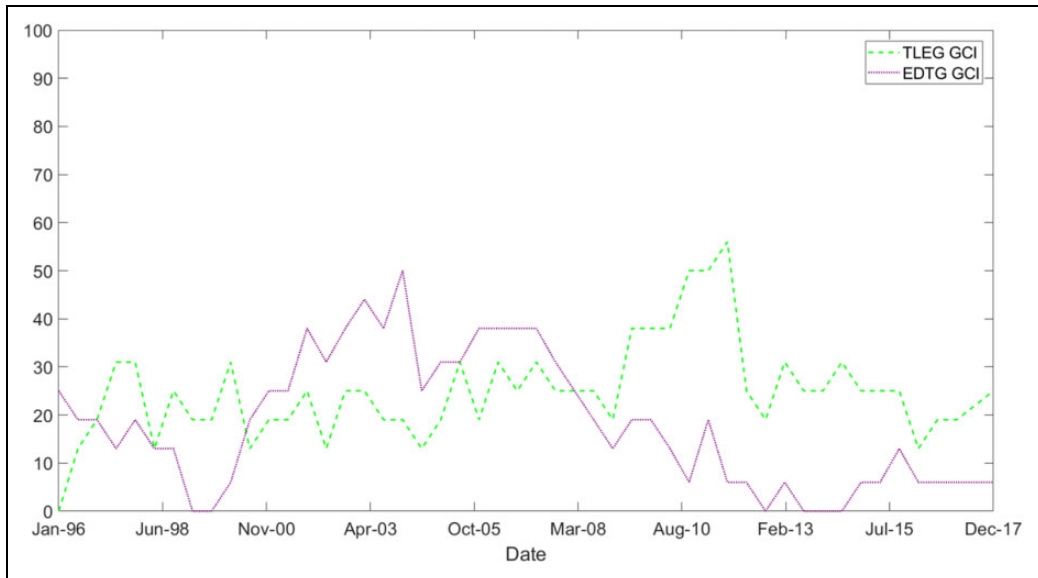


Figure 1. GCI, all countries.

Note: The index ranges from 0 to 100. The TLEG GCI denotes testing the null hypothesis $H_0 : TA \not\Rightarrow EG$ ($\not\Rightarrow$ means 'does not Granger-cause'). Analogously, the EDTG GCI denotes testing the null hypothesis $H_0 : EG \not\Rightarrow TA$. GCI: global connectivity index; TLEG: tourism-led economic growth; EDTG: economic-driven tourism growth.

move a mass amount of surplus labour with low productivity from the subsistence sector to a modern sector, which eventually solves the dilemma of unlimited labour supply and improves labour productivity to promote EG. To accompanying the global economy recovering, international tourism demand gradually increases, which triggers the expansion of tourism sector in developing countries. As such, the dependence of growth on tourism in developing economies remains relatively similar to its GFC levels in the post-GFC period with upward tendency as shown in Figure 2. At the same time, the evidence for the EDTG hypothesis leads to converse conclusions. The EDTG hypothesis has received wide support in developing countries during the years before the GFC, while the evidence seems to have vanished after the GFC. According to Nowak et al. (2007), if a developing country suffers from a foreign exchange constraint due to the presence of a financial crisis, such as the GFC, then any service trade expansion allows more imports of capital and intermediate goods. This leads to an increase in the relative price of the tourism products, which leads to a decrease in the share of service exports as part of the country's GDP and thus eases the impact of growth on tourism arrivals. Overall, we find that the tourism sector in developing countries remains a primary source for future EG, whereas EG has extinct its influence on international tourism.

With respect to developed economies, EG has almost lost its predictability for future TA as shown in Figure 3. This finding is consistent with the results obtained for developing economies suggesting that EG is not any more a factor attracting foreign tourists in post-GFC period. Meanwhile, the period immediately after the GFC signifies one of the highest values of the TLEG GCI for developed countries, see Figure 3. Accordingly, the economic recovery after the GFC has

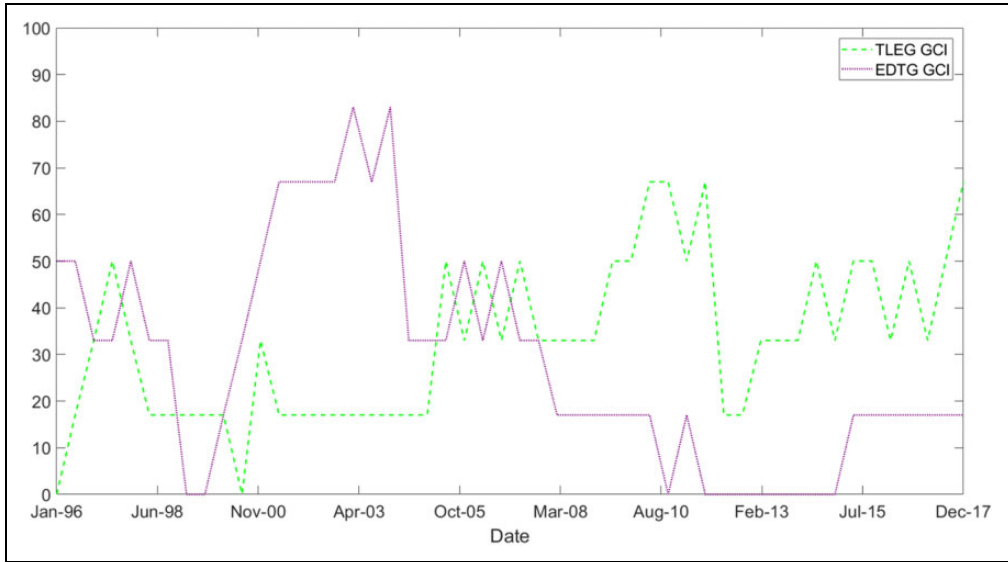


Figure 2. GCI, developing countries.

Note: The index ranges from 0 to 100. The TLEG GCI denotes testing the null hypothesis $H_0 : TA \not\Rightarrow EG$ ($\not\Rightarrow$ means 'does not Granger-cause'). Analogously, the EDTG GCI denotes testing the null hypothesis $H_0 : EG \not\Rightarrow TA$. GCI: global connectivity index; TLEG: tourism-led economic growth; EDTG: economic-driven tourism growth.

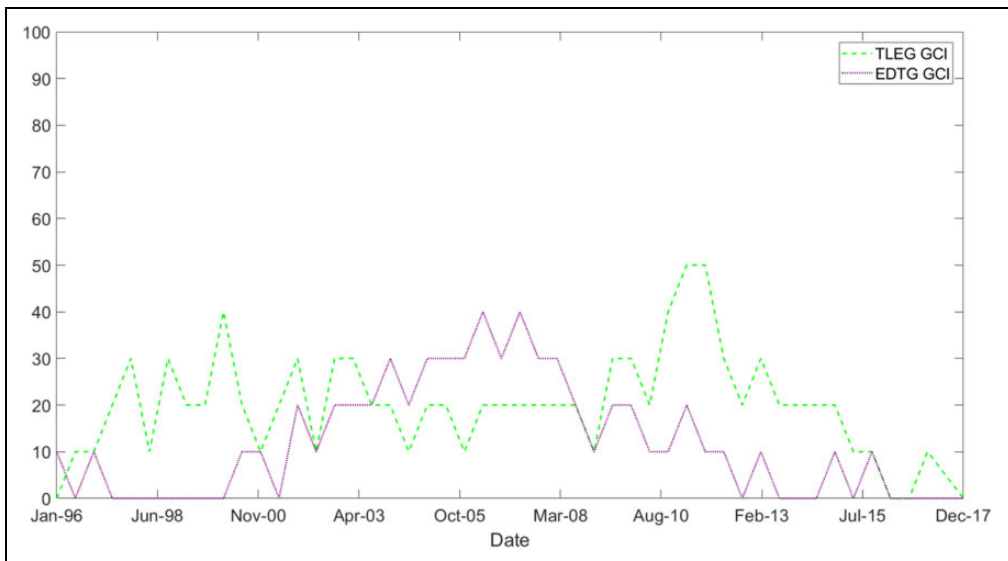


Figure 3. GCI, developed countries.

Note: The index ranges from 0 to 100. The TLEG GCI denotes testing the null hypothesis $H_0 : TA \not\Rightarrow EG$ ($\not\Rightarrow$ means 'does not Granger-cause'). Analogously, the EDTG GCI denotes testing the null hypothesis $H_0 : EG \not\Rightarrow TA$. GCI: global connectivity index; TLEG: tourism-led economic growth; EDTG: economic-driven tourism growth.

led to large share of labour force in developed countries to temporally shift to labour-intensive service-oriented industries, such as the tourism and hospitality industry, as the recession depressed the macroeconomic environment and extinguished a massive amount of white-collar jobs, in particular, in the financial sector. At the same time, the economic depression caused by the GFC induced fewer graduate job vacancies. Therefore, the tourism sector, which is labour-intensive and requires short training process, has been seen to recover faster than other capital-intensive and technology-intensive industries, and by this means it has temporally increased its share of the country's economy immediately after the GFC. This can be observed in Figure 3, where growth in developed economies has become more dependent on international tourism. However, the continuous and stable recovery of the developed economies has given an obvious boost to the capital-intensive industries so that the impact of international tourism on growth in developed countries has mildly disappeared during the post-crisis period. As a consequence of many former white-collar workers and university graduates moved to capital-intensive sectors pursuing a highly paid professional realisation. In sum, we find that the period of the GFC brought lots of structural changes in economy across the globe and, unfortunately, one of those changes is the diminutive impact of tourism on EG in developed nations. Overall, we find that the tourism sector in developing countries remains a primary source for future EG but not for their developed counterparts.

Robustness check

Size of the rolling window: Does it matter?

The existing literature has shown an increasing interest in estimating the time-varying relationship between TA and EG using a rolling window approach. However, little attention has been paid to the sensitivity of the empirical outcomes with respect to the choice of window size. As such, past studies seem to choose the window size arbitrary. Examples include the studies of Jackman (2014) – a window size of 3 years (annual data), Tang and Tan (2015) – a window size of 50 quarters (quarterly data), Tang and Abosedra (2016) – a window size of 120 months (monthly data), Liu and Song (2018) – a window size of 40 quarters (a mixture of quarterly and monthly data) and others.

To check whether the choice of a rolling window influences the time-varying results, we consider the following $rw \in \{40, 50, 60, 70, 80\}$, where rw refers to the size of the rolling window. Table 4 reports the rejection frequencies obtained from the time-varying MF Granger causality tests within a short-term (i.e. $h = 1$). The empirical outcomes provide evidence of causality from TA to EG for all but three countries in the case of $rw = 40$, while this number increases to six when $rw = \{50, 60\}$. Thus, we can conclude that the choice of a window size matters to some extent. By using a smaller rather than a larger rw , we are able to capture more precisely the shifts between causality to non-causality in the tourism–growth relationship. This finding supports the claim of Rossi and Inoue (2012) that predictive ability of the economic models tends to show up at smaller window sizes because it may be driven by the existence of instabilities in the predictive ability for which rolling windows of small size are advantageous.

Low-frequency estimation results

For comparability, we aggregate the simulated MF data into low-frequency (LF) data and again fit causality tests. Then, the LF results are juxtaposed with those obtained from the MF setting (see Table 5). This allows for a direct comparison between the MF and the traditional LF methods.

Table 4. Rejection frequencies from time-varying MF tests, different rolling windows.

Country	rw = 40			rw = 50			rw = 60			rw = 70			rw = 80		
	TA	EG	TA	TA	EG	TA	TA	EG	TA	TA	EG	TA	TA	EG	TA
Developing countries															
China	0.143	0.000	0.000	0.000	0.182	—	—	—	—	—	—	—	—	—	—
India	0.175	0.488	0.257	0.657	0.550	0.733	0.500	0.760	0.700	0.650	0.000	0.000	0.000	0.000	0.000
Indonesia	0.284	0.037	0.364	0.061	0.281	0.045	0.241	0.051	0.246	0.000	0.091	0.091	0.091	0.091	0.091
Malaysia	0.740	0.288	0.825	0.190	0.849	0.094	0.977	0.047	1.000	0.091	0.091	0.091	0.091	0.091	0.091
Mexico	0.046	0.202	0.111	0.273	0.090	0.326	0.165	0.329	0.159	0.116	0.116	0.116	0.116	0.116	0.116
Philippines	0.273	0.221	0.149	0.239	0.140	0.140	0.170	0.277	0.135	0.189	0.189	0.189	0.189	0.189	0.189
South Korea	0.284	0.275	0.394	0.313	0.528	0.247	0.658	0.152	0.768	0.087	0.087	0.087	0.087	0.087	0.087
Developed countries															
Australia	0.541	0.211	0.576	0.384	0.517	0.348	0.582	0.127	0.623	0.029	0.029	0.029	0.029	0.029	0.029
Austria	0.103	0.724	0.000	0.895	0.000	0.778	—	—	—	—	—	—	—	—	—
Bulgaria	0.000	0.143	0.000	0.000	0.000	0.000	—	—	—	—	—	—	—	—	—
Canada	0.046	0.229	0.061	0.404	0.079	0.404	0.051	0.392	0.058	0.391	0.391	0.391	0.391	0.391	0.391
Finland	0.061	0.020	0.026	0.026	0.034	0.000	0.053	0.000	0.111	0.000	0.000	0.000	0.000	0.000	0.000
Germany	0.492	0.066	0.490	0.000	0.439	0.000	0.323	0.000	0.381	0.000	0.000	0.000	0.000	0.000	0.000
Greece	0.455	0.000	—	—	—	—	—	—	—	—	—	—	—	—	—
Hungary	0.167	0.000	0.429	0.000	0.000	0.000	—	—	—	—	—	—	—	—	—
Italy	0.014	0.072	0.000	0.068	0.000	0.143	0.000	0.231	0.000	0.241	0.241	0.241	0.241	0.241	0.241
Japan	0.147	0.064	0.212	0.172	0.270	0.270	0.266	0.329	0.217	0.232	0.232	0.232	0.232	0.232	0.232
Netherlands	0.391	0.072	0.322	0.085	0.286	0.000	0.282	0.000	0.241	0.000	0.000	0.000	0.000	0.000	0.000
New Zealand	0.119	0.413	0.081	0.505	0.045	0.528	0.051	0.519	0.101	0.449	0.449	0.449	0.449	0.449	0.449
Spain	0.306	0.000	0.385	0.000	0.069	0.034	0.158	0.105	0.111	0.222	0.222	0.222	0.222	0.222	0.222
Switzerland	0.514	0.270	0.593	0.037	0.529	0.000	0.286	0.000	—	—	—	—	—	—	—
United Kingdom	0.083	0.064	0.121	0.091	0.180	0.022	0.291	0.013	0.246	0.014	0.014	0.014	0.014	0.014	0.014
United States	0.432	0.091	0.588	0.029	0.583	0.000	0.929	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: MF: mixed-frequency. rw denotes the rolling window size. The null hypothesis is specified as H_0 : TA \neq EG (\neq means 'does not Granger-cause'). Analogously, H_0 : EG \neq TA is defined. '—' denotes the case when the sample size is insufficient for undertaking time-varying analysis.

Table 5. Low-frequency versus mixed-frequency modelling.

Estimation method	Null hypothesis		Time horizon/rolling window size				
			<i>h</i> = 1	<i>h</i> = 2	<i>h</i> = 3	<i>h</i> = 4	<i>h</i> = 6
Full sample	MF	EG \nRightarrow TA	2	1	2	3	2
		TA \nRightarrow EG	8	3	1	2	4
	LF	EG \nRightarrow TA	5	1	1	4	2
		TA \nRightarrow EG	6	4	3	4	4
Time-varying (<i>rw</i> = 40)	MF	EG \nRightarrow TA	19	14	16	13	13
		TA \nRightarrow EG	22	14	10	12	13
	LF	EG \nRightarrow TA	21	18	12	9	9
		TA \nRightarrow EG	19	16	14	13	11
			<i>rw</i> = 40	<i>rw</i> = 50	<i>rw</i> = 60	<i>rw</i> = 70	<i>rw</i> = 80
Time-varying (<i>h</i> = 1)	MF	EG \nRightarrow TA	19	19	15	13	12
		TA \nRightarrow EG	22	18	17	17	16
	LF	EG \nRightarrow TA	21	19	15	13	8
		TA \nRightarrow EG	19	18	16	13	11

Note: LF: low-frequency; MF: mixed-frequency. The table reports the number of countries for which the null hypothesis is rejected. *rw* and *h* denote the rolling window size and the time horizon, respectively.

The following conclusions can be drawn from comparing the results between the LF and MF tests.⁴ First, both methods find only few cases causality when full sample framework is considered. When testing the TLEG hypothesis, the MF method discovers more cases of causality than its LF counterpart in short-term. Whereas, in long-term, the LF method discovers slightly more or equal number of causal cases than the MF approach. When testing the EDTG hypothesis, the LF method finds more causal patterns than the MF approach in short-term, whereas the evidence for long-term causality is inconclusive. Second, the time-varying MF method provides support for the short-term TLEG in larger number of countries than its LF counterpart. Third, the time-varying MF tests detect more cases of causality than its LF counterpart in terms of long-term EDTG. Based on these findings, we conclude that the MF method has a greater power in capturing causality than the LF approach in short-term horizons.

To further support the validity of this statement, we fit time-varying LF models of horizon *h* = 1 with different rolling window sizes. Considering the TLEG, the MF method determines a greater number of causal patters than those suggested by LF method across all rolling window sizes, apart from *rw* = 50. Further, the results from the MF method provide support for the EDTG hypothesis for a number of countries that is not less than those found by the LF approach. This finding pertains for all rolling window apart from *rw* = 40. In summary, our results show that the MF method is a better model in capturing short-term causal patterns than its LF counterpart while the long-term results are inconclusive.

Conclusion

This study provides new global evidence for the causal relationship between international TA and EG. The study period spans from January 1981 to December 2017 covering 23 developing and

developed countries. The causal relationship between tourism and EG is determined using the bootstrap MF Granger causality approach in association with a number of diagnostic tests. In addition, we apply the MF Granger causality with a rolling window technique to evaluate the stability of the TLEG and EDTG hypotheses over time. Our results show that the causality is time-varying in both the short-term and the long-term. We illustrate our results by constructing a new GCI. The index shows that international TA increase their role as a leading indicator for future EG after the GFC.

Our empirical results demonstrate that the tourism sector is a prominent source for future EG in a global perspective. First, we find that TA have an immediate short-term impact only in developing economies within Asia, while for developing countries outside Asia, the impact of tourism on EG has lagged effect. Second, the time-varying analysis reveals that the relationship between EG and TA is not stable over time. Specifically, we find that EG is a leading indicator for future international TA for all countries apart from China, Greece, Hungary and Spain. In terms of the TLEG hypothesis, the time-varying tests confirm its validity for all countries except for Bulgaria. The time-varying analysis provides substantial evidence for the validity of EDTG hypothesis in developing economies, while less support is provided for developed countries. The implication of this finding is twofold. On the one side, EG in developed economies is less likely to be affected by the tourism industry, especially after the GFC. On the other side, EG in European economies and the United States is well protected from demand-shocks coming from the global tourism industry.

One possible explanation is that tourism incomes are subject to sudden demand-shocks caused by crises. Indeed, national income generated from international tourism is unstable, especially during a financial turmoil such as the GFC. De Sausmarez (2007) demonstrates that damage caused by a crisis or disaster to the tourism sector has serious implications on the national economy. The tourism sector is considered as more fragile for developing countries than their richer counterparts. This is because tourism institutions in developing countries are more vulnerable and less capable to cope with a crisis as stated by WTO and UNDP (2017). Developed countries in Europe and North America have better institutions and, hence, are more competent to handle a crisis. Another possible explanation is that developing countries are anticipated to be hit by multiple crises due to poor institutional quality, such as economic crisis, political crisis and natural disasters (Hall, 2010). This is less likely to happen in developed countries so that demand-side shocks coming from the tourism sector could be digested inaudibly without causing a substantial impact on EG.

Our findings could deliver the following policy implications. Governments in developing countries are called to adopt strategic business planning to improve the collaboration and coordination within the tourism sector. Also, multi-industry partnerships are encouraged particularly at regional level in order to minimise the environmental damage and cushion the impact of a financial turmoil. In these lines, government assistance is demanded during the onset of economic crisis as well as during the post-crisis recovery period. Therefore, another important policy implication can be the instant access to financial aids. Indeed, accessing finance remains an important hurdle for tourism development in developing countries due to poor quality of the institutions. Moreover, as a consequence of the GFC, governments in developing countries can benefit of adopting crisis reaction plans to improve crisis resilience and recovery and help local companies to deal with external shocks that have a detrimental effect on their profits. In order to improve resilience, governments should provide stimulus and implement the green economy in the tourism sector for the future (WTO and UNDP, 2017). Unfortunately, numerous developing economies fail in their efforts to enhance product differentiation after the GFC, which lessens the crisis resilience of destinations according to WTO and UNDP (2017). We find that a possible reason for that is the

lack of industry diversification in combination with the tendency of high unemployment in the initial years after recessions led to higher dependence of the growth in developing economies on tourism in the post-GFC years. To mitigate the impact of a future crisis, we propose more intensive assistance and strategic decision from the central government, collaboration between public and private sectors should be strengthened wherever possible, in order to maximise synergies between national, regional and international stakeholders.

With respect to developed countries, we can elaborate several policy implications derived from our findings. Given the service-oriented structure of tourism industry, its expansion does not only contribute to EG at the aggregate level but it can also create new job opportunities at different skill levels. To mitigate the impact of a future GFC, central governments and non-profit organisations should aim at more intangible assets investment and corresponding on-the-job training should be considered within the tourism sector that can help accelerating human capital accumulations and improve labour productivity. Differently, Sheldon and Dwyer (2010) emphasise the importance of demand-creation strategies focusing on value added in tourism product to improve market share, rather than increasing the competitive advantage through cutting prices. Therefore, we suggest the revision and adjustment of the current tax systems in developed economies towards revenue-related taxes with the intention of reducing the amount of possible unfair financial burdens on the tourism sector. In addition, tourism expansion can also be used to ease up increased regional income inequalities at the post the GFC period. For example, the North–South divide in the United Kingdom. More importantly, diverting international tourists to less prosperous regions can directly mitigate the impact of a future crisis on the poor and vulnerable groups, for example, by making the tourism training more accessible for people from this background. In such a way, governments can use international tourism to not only promote regional economic prosperity but also help alleviate regional income inequalities.

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Data statement

The data that support the findings of this study are available from CEIC. Restrictions apply to the availability of these data, which were used under license for this study. Data are available at www.ceicdata.com with the permission of CEIC.

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Supplemental material

Supplemental material for this article is available online.

Notes

1. We have attempted a model specification with a constant term in equation (1) and have found that the inclusion of a constant term does not lead to significant quantitative changes in the empirical results.
2. Following Ghysels et al. (2016), we use Newey and West's (1987) kernel-based heteroskedasticity and autocorrelation consistent (HAC) covariance estimator with Newey and West's (1994) automatic bandwidth selection.
3. See the Online Appendix, Table A.1, for more details on individual countries data span.
4. For brevity, the actual LF results are not included in the article but are available upon request.

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