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Nonlinear and time-varying growth-tourism causality

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A B S T R A C T

This paper develops a panel smooth transition vector error correction model to investigate the economic growth-tourism causality. This model simultaneously resolves the estimation problems of nonlinearity, heterogeneity and endogeneity. Empirical results support that the causality is bi-directional, nonlinear, time- and country-varying in both the long run and short run. The real interest rate causes threshold effects on the link between growth and tourism. High levels of real interest rates lead to a longer time for the growth and tourism to return back to their long run equilibrium values; however, they strengthen the positive contribution from one of the variables to the other variable in the short run. Macroeconomic environment and policy are key factors that influence the threshold effects.

Introduction

The relationship between economic growth and tourism is the subject of many ongoing debates. A considerable body of literature has been devoted to exploring the causality between economic

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growth and tourism. Empirical results offer a broad array of potential correlations that converge on four divergent hypotheses (Chatziantoniou, Filis, Eeckels, & Apostolakis, 2013). The first two hypotheses suggest a unidirectional causality between the two variables, either from tourism to economic growth (*tourism-led economic growth hypothesis,* e.g. Balaguer & Cantavella-Jordá, 2002; Katircioglu, 2009) or its antithesis (*economic-driven tourism growth hypothesis,* e.g. Narayan, 2004; Oh, 2005; Payne & Mervar, 2010; Tang & Jang, 2009). The third hypothesis postulates the existence of a bidirectional relationship between tourism and economic growth (*bidirectional causality hypothesis,* e.g. Dritsakis, 2012; Kim, Chen, & Jang, 2006; Lee & Chang, 2008), whereas the fourth proposes that there is no causal relationship at all (*no causality hypothesis,* e.g. Ozturk & Acaravci, 2009).

While a large number of studies have concentrated on the analysis of the growth-tourism relationship, the investigation of the relationship in nonlinear, heterogeneous, time-varying circumstance has been nearly ignored. The ignorance may be one of the reasons that lead to divergent results in the growth-tourism relationship. As indicated by Wang (2012), it is quite possible that a linear framework oversimplifies the tourism-growth relationship and that the underlying relationship between the variables is indeed complex and nonlinear in nature. Ridderstaat, Croes, and Nijkamp (2014) also argue that the tourism-growth relationship cannot be strictly linear since the effects of tourism on economic growth adhere to the law of diminishing returns. Regarding the problems of heterogeneity and time variation, Hsiao (2003) indicates that in the presence of cross-section heterogeneity, assuming a common impact of a specific variable on other variables within panel data contexts may be misleading. Moreover, Arslanturk, Balcilar, and Ozdemir (2011) and Tang and Tan (2013) question the stability of the tourism-growth connection, showing that the magnitude of the connection fluctuates over time. Thus, in evaluating the causal relationship between tourism and economic growth, one needs to consider the problems of nonlinearity, heterogeneity, and time variation.

Recent studies have developed a nonlinear methodological framework for the examination of growth-tourism causality. However, there are at least three constraints that can be improved as the application is employed. First, the switching process in the Hansen's threshold model is *abrupt*, not smooth (Chang, Khamkaew, & McAleer, 2012; Po & Huang, 2008; Wang, 2012). This specification is impractical, especially for the low frequency data such as quarterly or annual data (Wu, Liu, & Pan, 2014). Second, the growth-tourism causality is not verified through proper statistical methods, which may generate the serious *endogeneity problem*. For example, Wang (2012) uses the model of Hansen (1999) to evaluate the threshold effect of exchange rate on the unidirectional causality from growth to tourism. Pan, Liu, and Wu (2014) adopt the panel smooth transition regression (PSTR) model to investigate the nonlinear impact of economic growth on tourism receipts. Third, the nonlinear approaches for the evaluation of the growth-tourism causality focus on a single country and ignore the *heterogeneity problem* between cross sectional units (Brida, Lanzilotta, & Sebestian, 2015; Phiri, 2015). In practice, the economic growth (or tourism receipts) in a specific group of countries (e.g. the Asian countries) may be disturbed by the worldwide recessions, but some countries may enter into or get out of recessions earlier than others. That is, both economic and tourism activities have interactive effects across countries. In this case, the nonlinear growth-tourism causality would be examined in a panel data context.

One approach for resolving the problems occurred in evaluating the relationship between tourism and growth is to employ the panel smooth transition vector error correction model (hereafter PST-VECM). A PST-VECM is constructed by rewriting the panel vector error correction model as a smooth transition one through the panel smooth transition regression (PSTR) model, recently introduced by Fok, van Dijk, and Franses (2004) and González, Teräsvirta, and van Dijk (2005). A basic PSTR model consists of two linear components combined by a nonlinear transition function and allows for smooth changes in the country-specific correlations, cross-country heterogeneity and time instability of the impact. Replacing the regressors in each PSTR model with all lagged dependent variables and one-period lagged error correction term, we can develop a PST-VECM.

The PSTR model is particularly useful for situations where the nonlinear dynamics are driven by a common regime-switching component, but where the response to this component may be different across variables. In addition, to conduct the estimation of the PSTR model, a panel data set that simultaneously covers time series and cross-sectional data is used. Obviously, a panel data set considers the heterogeneity of cross-sectional units and includes enough observations to improve estimation efficiency. Several studies have supported that the PSTR models have better fitting performance than other regime-switching models (Fouquau, Hurlin, & Rabaud, 2008; Wu, Liu, & Pan, 2013). Thus, the PST-VECM is a proper instrument for evaluating the nonlinear dynamics of the changes in tourism and growth and the nonlinear and time-varying causality between tourism and growth.

To run the PST-VECM, we have to select a specific transition variable. In practice, the variable of public policy, especially the monetary policy, frequently play an important role in influencing the dynamic processes of tourism and economic growth. For example, Liu and Yan (2012) find that interest rate (fluctuation) is negatively correlated with Sichuan domestic tourism demand. In particular, different levels of interest rates may lead to different impacts on the income-tourism causality. That is, the income-tourism causality may vary according to the interest rates within different regimes. However, the traditional linear VECM or panel VECM generates only one estimated coefficient for the tourism-growth relationship. One way to evaluate the threshold effects of monetary policy variables on the nonlinear growth-tourism causality is to specify the real interest rate as the transition variable in the PST-VECM. We return to the model specified in further detail later in the paper.

In sum, the purpose of this study is to investigate the causal relationship between tourism and economic growth in a nonlinear, time- and country-varying environment. To that end, we reconstruct the traditional vector error correction model (VECM) as a panel smooth transition vector error correction one (PST-VECM). To conduct the empirical estimation, we select the top 10 tourism receipts in the Asian and Australia countries over the period 1995–2013 as sample objects. Thus, there are 190 observations.

The rest of this paper is organized as follows. *The model* section briefly introduces the estimation model: PST-VECM. *Estimation and specification tests section* provides the procedures for testing and estimating the PSTR model. *Empirical result* section presents estimation results and policy implications, and the last section concludes the paper.

The model

Panel vector error correction model

To examine the relationship between economic growth and tourism, we begin our empirical framework by specifying the following baseline empirical model:

$$GDP_{it} = \alpha_{1i} + \gamma_{1t} + \beta_1 TOUR_{it} + \varepsilon_{1it} \tag{1}$$

$$TOUR_{it} = \alpha_{2i} + \gamma_{2t} + \beta_2 GDP_{it} + \varepsilon_{2it} \tag{2}$$

where GDP_{it} denotes the real per capita gross domestic product for country i at time t, and $TOUR_{it}$ denotes the real per capita international tourism receipts. α_i and γ_t are the time-invariant individual effect and time effect, respectively. The former captures any country-specific unobservables that are relatively stable over time. ε_{it} is the error term.

In fact, Eqs. (1) and (2) are parsimonious specifications that only focus on the bivariate long-run link between *GDP* and *TOUR*. However, the validity of the specifications requires that the variables in Eqs. (1) and (2) are nonstationary or integrated of the same order. In that case, they would have a stationary error term, implying that they form a cointegrating vector (Asteriou & Hall, 2007). Once a set of variables forms a cointegration relationship, such relationship should exist even if more variables are added to the model (Herzer & Grimm, 2012).

Before estimating Eqs. (1) and (2), we need to test the properties of the variables using the standard panel unit root tests. If the test results cannot reject the null hypothesis of a unit root in level, the variables are non-stationary. However, if the first differences of the series are stationary, implying that they are integrated of order one, $I(1)$, we can then proceed to panel cointegration tests to explore whether there is a long-run equilibrium relationship between *GDP* and *TOUR*.

Given that the variables are cointegrated, we estimate a panel vector error correction model (PVECM) to investigate whether the relationship between *GDP* and *TOUR* is of a causal nature. Following Engle and Granger (1987), we employ the following two-step procedure (Pesaran, Shin, & Smith, 2001). First, the long-run models specified in Eqs. (1) and (2) are estimated to obtain their residuals. Second, defining the lagged residuals from Eqs. (1) and (2) as the error correction terms (e_{1it-1} and e_{2it-1}), the following PVECM is generated:

$$\Delta GDP_{it} = \alpha_{1i} + \lambda_1 e_{1it-1} + \sum_{k=1}^{p} \gamma_{11k} \Delta GDP_{it-k} + \sum_{k=1}^{p} \gamma_{12k} \Delta TOUR_{it-k} + u_{1it} \tag{3}$$

$$\Delta TOUR_{it} = \alpha_{2i} + \lambda_2 e_{2it-1} + \sum_{k=1}^{p} \gamma_{21k} \Delta TOUR_{it-k} + \sum_{k=1}^{p} \gamma_{22k} \Delta GDP_{it-k} + u_{2it} \tag{4}$$

where Δ is the first-difference operator and p is the optimal lag length determined by standard information criteria (AIC and BIC). Granger causality can be examined in two ways: (1) by testing the significance of the lagged differences of the variables in the above mentioned equations through a joint Wald; this is a measure of the *short-run or weak Granger causality*; (2) by investigating the significance of the error-correction term in the above equations as a sufficient measure of the *long-run causality*. The null hypothesis of no short-run causality can be tested based on $H_0 : \gamma_{12k} = 0$ and $H_0 : \gamma_{22k} = 0$ for all i, k. That is, short-run causality can be examined by evaluating the statistical significance of the partial F-statistic associated with the corresponding regressor. Regarding the long-run causality, it can be tested by the statistical significance of λ_1 and λ_2, respectively.

Panel smooth transition regression (PSTR) model

This paper constructs the PST-VECM to evaluate the threshold effect of the interest rate on the tourism-growth causality. In the situation of two extreme regimes and a single transition function, the PSTR model can be written as follows:

$$y_{it} = \mu_i + \beta_0' x_{it} + \beta_1' x_{it} W(z_{it}; \gamma, c) + \varepsilon_{it} \tag{5}$$

where i and t have the same meanings as in Eq. (1). y_{it} is a dependent variable and x_{it} is a K-dimensional vector of time-varying exogenous variables or lagged dependent variables. μ_i is a time-invariant individual effect. $W(z_{it}; \gamma, c)$ is the transition function bounded between 0 and 1 and dependent on the transition variable z_{it}. The transition variable can be an exogenous variable or a combination of lagged endogenous variables (see van Dijk, Terasvirta, & Franses, 2002). γ is the transition parameter that describes the slope of the transition function. c is a threshold parameter. γ and c are endogenously estimated. ε_{it} is the residual. The simple PSTR model can be thought of as a regime-switching model that allows for two regimes, associated with the extreme values of the transition function, $W(z_{it}; \gamma, c) = 0$ and $W(z_{it}; \gamma, c) = 1$, where the transition from one regime to the other is smooth. β_0' and β_1' are estimated coefficients in two different regimes.

González et al. (2005) and the followers suggest that the following specification can be used for the transition function:

$$W(z_{it}; \gamma, c) = \left[1 + \exp\left(-\gamma \prod_{j=1}^{m} (z_{it} - c_j)\right)\right]^{-1} \tag{6}$$

where $\gamma > 0$ and $c_1 \leqslant c_2 \leqslant \cdots \leqslant c_m$. m is the number of location parameters. In practice, González et al. (2005) indicate that it is sufficient to consider only the cases of $m = 1$ or $m = 2$ to capture the nonlinearity due to regime switching. When $m = 1$, the transition function is a logistic one, and $m = 2$, the transition function is an exponential type. The logistic function is a continuous, asymmetric, and monotone increasing function of z_{it}. It can describe the asymmetric volatility of time series and the smooth transition in different regimes. The exponential function is a continuous, symmetric, and monotone increasing function of z_{it}. In addition, the PSTR model can be easily extended to more than two different regimes:

$$y_{it} = \mu_i + \beta_0' x_{it} + \sum_{j=1}^{r} \beta_j' x_{it} W_j(z_{it}; \gamma_j, c_j) + \varepsilon_{it} \tag{7}$$

where r is the number of transition functions and $r + 1$ is the number of regimes. $W_j(z_{it};\gamma_j,c_j)$, $j = 1,\ldots,r$, are the transition functions (see Eq. (6)).

Panel smooth transition vector error correction model

We can construct the panel VECM (Eqs. (3) and (4)) as a panel smooth transition vector error correction (PST-VECM) based on Eq. (7):

$$\Delta GDP_{it} = \alpha_{1i} + \lambda_1 e_{it-1} + \sum_{k=1}^{p}\gamma_{11k}\Delta GDP_{it-k} + \sum_{k=1}^{p}\gamma_{12k}\Delta TOUR_{it-k} + \sum_{j=1}^{r}\left(\lambda'_{1j}e_{it-1} + \sum_{k=1}^{p}\gamma'_{11k}\Delta GDP_{it-k} + \sum_{k=1}^{p}\gamma'_{12k}\Delta TOUR_{it-k}\right)W_j(z_{it};\gamma_j,c_j) + u_{1it} \quad (8)$$

$$\Delta TOUR_{it} = \alpha_{2i} + \lambda_2 e_{it-1} + \sum_{k=1}^{p}\gamma_{21k}\Delta TOUR_{it-k} + \sum_{k=1}^{p}\gamma_{22k}\Delta GDP_{it-k} + \sum_{j=1}^{r}\left(\lambda'_{2j}e_{it-1} + \sum_{k=1}^{p}\gamma'_{21k}\Delta TOUR_{it-k} + \sum_{k=1}^{p}\gamma'_{22k}\Delta GDP_{it-k}\right)W_j(z_{it};\gamma_j,c_j) + u_{2it} \quad (9)$$

In Eqs. (8) and (9), the short-run causality relationship between *GDP* and *TOUR* depends on $\gamma_{12k} + \gamma'_{12k}\sum_{j=1}^{r}W_j(z_{it};\gamma_j,c_j)$ and $\gamma_{22k} + \gamma'_{22k}\sum_{j=1}^{r}W_j(z_{it};\gamma_j,c_j)$, for all $k = 1,2,\ldots,p$. The long-run causality between the two variables $\lambda_1 + \sum_{j=1}^{r}(\lambda'_{1j})W_j(z_{it};\gamma_j,c_j)$ and $\lambda_2 + \sum_{j=1}^{r}(\lambda'_{2j})W_j(z_{it};\gamma_j,c_j)$. Obviously, the transition variable z_{it} plays an important role in the causality between growth and tourism.

Estimation and specification tests

In estimating Eqs. (8) and (9), two problems of specification need to be resolved, including the choice of transition variable and the determination of the number of transition functions. Following González et al. (2005), this study adopts a three-step procedure for estimating the constructed PST-VECM. First, we test the linearity against the PST-VECM. Once the linearity is rejected, we determine the optimal number of transition functions by conducting the no remaining nonlinearity test. Finally, we eliminate the individual effects by removing individual-specific means, and then apply nonlinear least squares to estimate the transformed model.

Choice of transition variable

In PSTR models, the observations in the panel are divided into at least two regimes depending on whether the transition variable is lower or larger than specific threshold values. That is, the transition variable plays a key role in influencing the nonlinear causality between growth and tourism. Thus, the selection of a proper transition variable is important.

The theory of inter-temporal consumption choice provides a good basis for analyzing the impact of interest rates on tourism (Ando & Modigliani, 1963). The residents of a country adjust the proportion of consumption and savings in disposable income according to changes in interest rates. When interest rates increase, current consumption will decrease and savings rise. Once the distribution of current consumption changes, people's travel affordability and travel demand will be influenced. Moreover, fluctuations in interest rates directly affect tourists' return on assets, which generates an income effect to adjust tourism spending.

The main reason we choose the real interest rate as the transition variable is that this variable is a representative instrument of monetary policy, can simultaneously influence tourism and economic growth, and is theoretically and empirically supported in the literature. For example, Gul, Asik, and Gurbuz (2014) find empirical evidence that the effect of interest rate on tourist spending can be accepted as a strong influential factor. FaridSaymeh and Orabi (2013) indicate that current interest rate has an influence power on economic growth rate. As indicated by van Dijk et al. (2002), the transition variable can be an exogenous or a lagged endogenous one. Thus, each chosen transition variable will generate individual policy implications. In spite of this, under certain circumstances, different transition variables may lead to same policy propositions. For example, according to the covered interest rate parity (see, for example, Chaboud & Wright, 2005), the flow of capital stops as the difference between domestic interest rate and foreign interest rate is equal to the difference between forward exchange rate and spot exchange rate. Thus, the (real) interest rate has implied exchange rate.

Linearity and no remaining nonlinearity tests

Following Fouquau et al. (2008), in testing the linearity of Eqs. (8) and (9), we replace the transition function $W_j(z_{it}; \gamma_j, c_j)$ with the first order Taylor expansion around $\gamma = 0$. Let $r = 1$, we have the following auxiliary equation:

$$\Delta GDP_{it} = \pi_{01i} + \pi_1 e_{it-1} + \sum_{k=1}^{p} \pi_{11k} \Delta GDP_{it-k} + \sum_{k=1}^{p} \pi_{12k} \Delta TOUR_{it-k} + \pi'_1 z_{it} e_{it-1} + \sum_{k=1}^{p} \pi'_{11k} z_{it} \Delta GDP_{it-k} + \sum_{k=1}^{p} \pi'_{12k} z_{it} \Delta TOUR_{it-k} + \eta_{1it} \tag{10}$$

$$\Delta TOUR_{it} = \pi_{02i} + \pi_2 e_{it-1} + \sum_{k=1}^{p} \pi_{21k} \Delta TOUR_{it-k} + \sum_{k=1}^{p} \pi_{22k} \Delta GDP_{it-k} + \pi'_2 z_{it} e_{it-1} + \sum_{k=1}^{p} \pi'_{21k} z_{it} \Delta TOUR_{it-k} + \sum_{k=1}^{p} \pi'_{22k} z_{it} \Delta GDP_{it-k} + \eta_{2it} \tag{11}$$

Previous studies have provided three testing methods: the Wald (LM), Fisher (LM_F), and likelihood ratio test (LRT) to conduct the linearity test and no remaining nonlinearity test. However, van Dijk et al. (2002) argue that the Fisher test statistics have better size properties in small samples than the other two. Thus, we apply the LM_F as the selection standard for the number of transition functions.

Let SSR_0 to be the panel sum of squared residuals under H_0: $r = 0$ (i.e. the linear panel model with individual effect), and SSR_1 to be the panel sum of squared residuals under H_1: $r \geqq 1$ (i.e. the PSTR model with at least two regimes or one transition function), then the Fisher (LM_F) test can be written as:

$$LM_F = [(SSR_0 - SSR_1)/mK]/[SSR_0/(TN - N - mK)] \tag{12}$$

where K is the number of explanatory variables. Under the null hypothesis, the LM_F statistic has an approximate $F[mK, TN - N - mK]$ distribution.

The sequential procedure is used to test the null hypothesis of no remaining nonlinearity in the transition function as the linearity is rejected. First, we test $H_0: r = 1$ (i.e. one transition function) against $H_1: r \geqslant 2$ (i.e. at least two transition functions). We would test the three-regime model as the null hypothesis is rejected. The testing continues until the first acceptance of null hypothesis of no remaining heterogeneity. The significance level must be decreased by the factor $0 < \tau < 1$ to avoid the excessively large models (González et al., 2005). This study uses $\tau = 0.2$.

Empirical result

The top 10 international tourism receipts in the Asian and Australia countries over the period 1995–2013 are used as sample objects. These countries are Australia, China, Hong Kong, Indonesia, Japan, South Korea, Macao SAR, Malaysia, Singapore, and Thailand. There are several reasons that this paper uses the sample data to perform empirical study. First, as emphasized in our paper, in evaluating the tourism-growth causality, one needs to consider the *heterogeneity* of cross-sectional countries. That is, we have to use a panel data set to conduct empirical estimation. However, there is a trade-off between the number of countries and the length of time period due to the availability of data. That is, the longer the time series is covered, the fewer the countries we can choose.

Second, both tourism and economic growth can generate *spatial effect* (Lau & Lee, 2008; Yang & Fik, 2014), which restricts relevant analysis to specific number of countries, and the causality between tourism and growth varies with the specification of specific countries with spatial dependence. While some other countries have spatial dependence with the selected sample countries, their *tourism receipts are tiny relative to GDPs*. Thus, this paper chooses the ten countries to perform empirical estimation, and the maximum length of period for these countries is 19.

Third, some *previous studies* have used similar length of time period to engage in empirical estimation. For example, Ozturk and Acaravci (2009) investigate the long-run relationship between the real *GDP* and international tourism in Turkey during the time period 1987–2007. Mahmoodi and Mahmoodi (2014) examine the causality relationship between foreign direct investment, exports and economic growth in two panels of Asian countries (three developed and eight developing countries) over the 1986–2010. Moreover, *panel VARs with a short period of time* (typically less than 10) have been investigated, for example, by Holtz-Eakin, Newey, and Rosen (1988) and Binder, Hsiao, and Pesaran (2005).

Fourth, the estimation in our paper is performed by logical procedures and then obtains reasonable results. Once the observations are insufficient, the estimation is unable to be executed. That is, the co-integration and causality relationship really exist by using the specified dataset. In light of this, the estimation results have certain reference value.

Finally, the main purpose of this paper is to provide a new approach to investigate the tourism-growth causality. However, the empirical estimation can be further re-examined when the length of time series is extended in the future (for example, 10 years later).

Two key variables used in this study are gross domestic product, as a proxy of economic growth (similarly with Espinoza, Fornari, & Lombardi, 2012; Lombardi & Van Robays, 2011; Peersman & Van Robays, 2012), and the international tourism receipts, as a proxy of tourism income (similarly with Dritsakis, 2012; Tang, 2011; Tang & Tan, 2013). Both the variables are seasonally adjusted and expressed as their real per capita terms. This treatment can exclude the disturbance of changes in the seasonal cycle, price level, and population. One typical proxy of monetary policy is the interest rate measured by the real interest rate to exclude the disturbance from inflation. The data set sources from World Bank (2015). Table 1 reports the descriptive statistics for the variables.

The results of the panel unit root tests are reported in Table 2. At the conventional level of significance (5%), the real per capita gross domestic product (*GDP*) and real per capita international tourism receipts (*TOUR*) are nonstationary, and the real interest rate (*RIR*) is stationary. However, *GDP* and *TOUR* are indeed stationary in first difference.

Having confirmed that the variables *GDP* and *TOUR* are integrated of order one (i.e. $I(1)$), we can investigate whether there is a long-run cointegration between them. To this end, we execute the residual based panel cointegration test developed by Pedroni (2004). Pedroni (2004) panel cointegration test offers considerable flexibility as it allows for heterogeneity among the cross-sectional units. That is, the Pedroni (2004) test captures both the within- and between-dimensions of the panel. The test result strongly rejects the null hypothesis of no cointegration between *GDP* and *TOUR* at the 5% significance level.

The traditional long- and short-run Granger causality tests are reported in Table 3. Evidently, there is two-way causal relationship between *GDP* and *TOUR* in the short-run as both individual (lagged) regressors are significantly different from zero at 5% confidence level. According to the positive adjustment coefficients (0.0026 and 0.3386), we also find a significant two-way causal relationship between *GDP* and *TOUR* in the long-run. That is, increases in *GDP* are both a result of as well as a cause of increases in *TOUR*. These results are similar to those in works of Dritsakis (2012) and Lee and Chang (2008).

The test and estimation results for the PST-VECM (i.e. Eqs. (8) and (9)) are reported in Tables 4–6. In Table 4, the linearity tests lead to a rejection of the null hypothesis of linearity for all PST-VECM specifications with different numbers of location parameters ($m = 1,\ 2$). Evidently, the relationships between growth and tourism are nonlinear. Thus, employing a nonlinear PST-VECM approach to

Table 1
Descriptive statistics.

Variable	Mean	Std. dev.	Max.	Min.	Skewness	Kurtosis	J–B	Probability
GDP_{it}	17857	13890	54091	777.33	0.17	1.67	14.86	0.00
$TOUR_{it}$	3252	11073	87562	6.20	5.54	35.93	9557.43	0.00
RIR_{it}	4.28	4.10	14.17	−24.60	−1.60	14.88	1197.86	0.00

Notes: GDP_{it}, $TOUR_{it}$, and RIR_{it} denote real per capita gross domestic product, real per capita international tourism receipts, and real interest rate, respectively. J–B (Jarque–Bera) is a test statistic for testing whether the series are normally distributed.

Table 2
Panel unit root tests.

Variable	LLC	IPS	ADF-Fisher Chi-square	PP-Fisher Chi-square
GDP_{it}	4.4980[1.00]	6.5764[1.00]	4.8571[0.99]	10.252[0.96]
$TOUR_{it}$	6.4527[1.00]	8.5679[1.00]	2.3820[1.00]	2.0854[1.00]
RIR_{it}	−6.1427[0.00]	−5.4072[0.00]	67.332[0.00]	68.126[0.00]

Notes: GDP_{it}, $TOUR_{it}$, and RIR_{it} denote real per capita gross domestic product, real per capita international tourism receipts, and real interest rate, respectively. The null hypothesis is that the series are nonstationary and the tests are conducted in level values of variables. The digits in brackets are *p*-values. Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution.

Table 3
Panel VECM estimation results.

Dependent variable	ΔGDP_{it} Coefficient		$\Delta TOUR_{it}$ Coefficient	
Adjustment coefficient	0.0026	(3.93)***	0.3386	(7.95)***
C	1050.5	(5.87)***	1279.2	(8.87)***
ΔGDP_{it-1}	0.2683	(2.68)**	−0.2700	**(−3.35)***
ΔGDP_{it-2}	−0.2985	(−3.03)***	−0.1395	(−1.76)*
ΔGDP_{it-3}	0.1138	(1.16)	−0.2435	(−3.09)***
ΔGDP_{it-4}	−0.1889	(−1.67)	−0.0139	(−0.15)
$\Delta TOUR_{it-1}$	−0.6198	(−3.79)***	0.3386	(−3.55)***
$\Delta TOUR_{it-2}$	−0.3534	(−2.66)**	−0.4667	(−8.15)***
$\Delta TOUR_{it-3}$	−0.1379	(−0.96)	−0.8717	(2.64)**
$\Delta TOUR_{it-4}$	0.8990	(3.36)***	0.3064	(6.70)***
$\bar{R}^2$	0.6133		0.9329	
Wald test	26.0746	[0.00]	35.4574	[0.00]

Notes: GDP_{it} and $TOUR_{it}$ denote real per capita gross domestic product and real per capita international tourism receipts, respectively. The digit in the parenthesis is the lag length of the corresponding variable. The digits in parentheses are the *t*-statistics, and in brackets are the *p*-values. The null hypothesis of the Wald test is that the corresponding coefficients of lagged $TOUR_{it}$ are simultaneously equal to zero for the model with GDP_{it} as dependent variable, and the corresponding coefficients of lagged GDP_{it} are simultaneously equal to zero for the model with $TOUR_{it}$ as the dependent variable.
*, **, and *** denote significance level at 10%, 5%, and 1%, respectively.

model the relationships is proper, and a linear panel VECM approach may distort the influence of the real interest rate on the relationship between growth and tourism.

Table 5 displays the results of the no remaining nonlinearity tests and provides information about the optimal number of transition functions. As mentioned above, van Dijk et al. (2002) indicate that F versions of the LM test statistics have better size properties in small samples than do the χ^2 variants. Thus, this study uses LM_F as the selection criterion for the number of transition functions. For Eqs. (8) and (9), in cases of one location parameter ($m = 1$) and two location parameters ($m = 2$), there has only one transition function (i.e. $r = 1$).

According to the test results in Table 5, the PST-VECMs have one transition function. To identify which model is optimal for evaluating the nonlinear causality relationship between growth and tourism (i.e., Eqs. (8) and (9)), we use the AIC and BIC. As a result, the PST-VECM with one transition

Table 4
Linearity test.

		Eq. (8)		Eq. (9)	
Transition variable	*RIR*				
No. of location parameters (m)		$m = 1$	$m = 2$	$m = 1$	$m = 2$
Testing statistic	LM	12.499	15.136	46.875	58.615
		[0.014]	[0.057]	[0.000]	[0.000]
	LM_F	3.091	1.852	15.455	10.583
		[0.018]	[0.073]	[0.000]	[0.000]
	LRT	13.05	15.956	56.204	74.333
		[0.000]	[0.000]	[0.000]	[0.000]

Notes: the dependent variables in Eqs. (8) and (9) are real per capita gross domestic product and real per capita tourism receipts in first-differences, respectively, i.e., ΔGDP_{it} and $\Delta TOUR_{it}$. *RIR* denotes the real interest rate. The digits in brackets are the *p*-values. H_0: linear model against H_1: PSTR model with at least one threshold variable. LM, LM_F, and LRT denote the statistics of the Wald test, Fisher test, and likelihood ratio test, respectively.

Table 5
Test of no remaining nonlinearity.

		Eq. (8)		Eq. (9)	
Transition variable	*RIR*				
No. of location parameters (m)		$m = 1$	$m = 2$	$m = 1$	$m = 2$
Testing statistic	LM	3.103	12.978	14.652	16.323
		[0.541]	[0.113]	[0.072]	[0.083]
	LM_F	0.676	1.468	0.951	6.783
		[0.610]	[0.176]	[0.051]	[0.063]
	LRT	3.136	13.574	17.393	12.513
		[0.535]	[0.094]	[0.002]	[0.067]

Notes: the dependent variables in Eqs. (8) and (9) are real per capita gross domestic product and real per capita tourism receipts in first-differences, respectively, i.e., ΔGDP_{it} and $\Delta TOUR_{it}$. *RIR* denotes the real interest rate. The digits in brackets are the *p*-values. H_0: PSTR with one threshold variable ($r = 1$) against H_1: PSTR with at least two threshold variables ($r \geqq 2$). LM, LM_F, and LRT denote the statistics of the Wald test, Fisher test, and likelihood ratio test, respectively.

function ($r = 1$) and one location parameter ($m = 1$) is the optimal one. Table 6 displays the parameter estimates of the optimal PST-VECM.

The long-run causality between growth and tourism can be investigated by using the estimated adjustment coefficients in Eqs. (8) and (9), i.e., $(\lambda_1, \lambda'_{11})$ and $(\lambda_2, \lambda'_{21})$. In Eq. (8), the estimated transition speed (γ) and threshold value (c) are 2.5369 and 1.808%, respectively. The influence of real interest rate on adjustment coefficient is statistically significant, permanently negative, and time- and country-varying, i.e., $-0.2077 + 0.1138 * W(RIR_{it};\ 2.5369,\ 1.808) < 0$, depending on RIR_{it} in different regimes. In two extreme circumstances, i.e., $W(\cdot) = 0$ and $W(\cdot) = 1$, the adjustment coefficients are -0.2077 and -0.0939, respectively. Evidently, the larger the real interest rate is, the smaller the adjustment coefficient would be. That is, a high level of real interest rate will lengthen the time for the economic growth to return back to its long-term equilibrium value. The reason may be that tourism can stimulate investment in new infrastructure and create economies of scale, which further drives economic growth (Brida, Carrera, & Risso, 2008); however, the new investment will be depressed at high levels of real interest rates. This negative relationship between real interest rate and tourism demand is also supported by Gu (1995).

In Eq. (9), the estimated transition speed and threshold value are 41.024 and 0.831%, respectively. The impact of real interest rate on adjustment coefficient is also statistically significant, permanently negative, and time- and country-varying, i.e., $-0.2575 + 0.2570 * W(RIR_{it};\ 41.024,\ 0.831) < 0$. In the two extreme circumstances, the adjustment coefficients are -0.2575 and -0.0005, respectively. Evidently, a higher real interest rate is harmful for the tourism receipts to quickly return back to its long-term equilibrium. One of the reasons is that high real interest rates discourage economic growth through the decline in private consumption and investment, which leads to a longer time for the

Table 6
PST-VECM estimation results.

Parameter	Eq. (8)		Parameter	Eq. (9)	
γ	2.5369		γ	41.024	
C	1.808		C	0.831	
λ_1	−0.2077	(−3.93)***	λ_2	−0.2575	(−1.81)*
λ'_{11}	0.1138	(1.17)	λ'_{21}	0.2570	(1.90)*
γ_{111}	5.7553	(4.18)***	γ_{211}	2.0511	(3.92)***
γ_{112}	−2.4867	(−2.59)***	γ_{212}	1.0070	(2.93)***
γ_{113}	2.7912	(2.40)**	γ_{213}	1.4809	(1.94)*
γ_{114}	−2.1062	(−2.24)**	γ_{214}	−3.6524	(−2.97)***
γ'_{111}	−5.3517	(−2.67)***	γ'_{211}	−2.8035	(−4.69)***
γ'_{112}	1.9579	(1.70)	γ'_{212}	−0.4151	(−1.12)
γ'_{113}	−2.5807	(−1.61)	γ'_{213}	−1.0240	(−1.23)
γ'_{114}	3.8595	(2.76)***	γ'_{214}	4.5615	(3.75)***
γ_{121}	1.5317	(5.07)***	γ_{221}	−1.3842	(−2.17)**
γ_{122}	−1.0938	(−2.15)**	γ_{222}	−1.8259	(−3.47)***
γ_{123}	0.8993	(1.86)*	γ_{223}	−0.6461	(−0.63)
γ_{124}	−1.0701	(−2.29)**	γ_{224}	2.4207	(3.49)***
γ'_{121}	−0.4667	(−2.55)***	γ'_{221}	1.4123	(2.20)**
γ'_{122}	−0.8717	(−4.15)***	γ'_{222}	1.7197	(3.23)***
γ'_{123}	0.3064	(2.64)***	γ'_{223}	0.5197	(0.50)
γ'_{124}	1.4421	(3.70)***	γ'_{224}	−2.4639	(−3.59)***
AIC	15.438		AIC	11.035	
BIC	15.639		BIC	11.390	

Notes: the dependent variables in Eqs. (8) and (9) are real per capita gross domestic product and real per capita tourism receipts in first-differences, respectively, i.e., ΔGDP_{it} and $\Delta TOUR_{it}$. The digits in parentheses are the t-statistics. ***, **, and * denote the significance level at 1%, 5%, and 10%, respectively.

tourism receipts to adjust towards its long run equilibrium. Barro and Becker (1989) and Hansen and Seshadri (2014) support the negative relationship between real interest rate and economic growth.

Regarding the short run causality, it is detected through the test of significance of t-statistics or F-statistics of the relevant coefficients on the first difference series. According to the significance of the estimated coefficients (γ_{12k}, γ'_{12k}) and (γ_{22k}, γ'_{22k}), $k = 1,\ldots,4$, there exists a bi-directional causality between growth and tourism in the short run. Similar to results in the long-run causality, the short-run causality varies with time and across countries, and depends on the RIR_{it}. However, the estimated coefficients γ'_{12k}, $k = 1,\ldots,4$, in Eq. (8) show that increase in RIR_{it} strengthens the positive contribution from tourism to economic growth as RIR_{it} is larger than the threshold (1.808%). The estimated coefficients γ'_{22k}, $k = 1,\ldots,4$, in Eq. (9) report similar results. That is, an increase in RIR_{it} reinforces the positive short-run contribution from economic growth to tourism as RIR_{it} is over the threshold. Again, this time- and country-varying bi-directional causality cannot be explored by previous studies.

Makochekanwa (2013) indicates that the tourism-led-growth-hypothesis is more applicable to developing or emerging economies since such economies rely on tourism as a key foreign exchange earner. However, Lanza, Temple, and Urga, (2003) find that the economic-driven tourism growth hypothesis commonly occurs for highly-industrialized countries. The sample objects used in this study cover five developed countries (Australia, Hong Kong, Japan, Singapore, and South Korea) and five developing ones (China, Indonesia, Macao SAR, Malaysia, and Thailand); therefore, the finding of bi-directional causality between tourist receipts and economic growth under the linear or nonlinear framework is expected.

In sum, there is a bi-directional causality between growth and tourism in the short run and long run, and the causality varies with the real interest rate (RIR_{it}). While Brida et al. (2015) and Phiri (2015) also support the bi-directional causal relationship between tourist and growth, their results are based on single one sample country. This markedly ignores the interaction of tourism and economic activities within a specific group of countries, namely the heterogeneity in the causality. In addition, their estimated causality cannot respond the impact of macroeconomic environments (e.g. the real interest rate in this study) on the causality. That is, our estimated bi-directional causality is nonlinear and varies with time and across countries, depending on the real interest rate in different regimes. Finally, these two articles do not verify, through strict testing methods, whether nonlinear models are better than linear models in testing the causality. As to the traditional linear cointegration model and the error correction model, they generate single one constant growth-tourism causality, and cannot evaluate the role of real interest rate in the causality.

Regime-switching and time- and country-varying causality

Long run causality

Based on the estimation results in Eq. (9), we can depict the dynamic processes of adjustment coefficient (i.e., the long run causality), real interest rate and its threshold for individual countries in each period, as shown in Fig. 1. A constant adjustment coefficient occurs in South Korea and Thailand at −0.2575 and in Japan at −0.0005. The remaining countries have faced at least one switching point in their adjustment coefficients. In addition, China, Indonesia, and Malaysia have the largest volatility in the adjustment coefficients. The smooth switching process will appear if the sample period can be extended to cover enough observations in the future.

Most of the developed countries in this study (Australia, Hong Kong, Japan, and South Korea) have real interest rates above the threshold (0.831%) during the entire sample period, implying that their adjustment coefficients are smaller than the developing countries, and the time for the tourism receipts to adjust towards their long-run equilibrium is longer. Contrarily, for the developing countries, including China, Macao SAR, Indonesia, and Malaysia, the real interest rates are below the threshold in at least four of nineteen years. Thus, the tourism receipts need less time to adjust towards their long-run equilibrium values.

In the sample period, two well-known financial crises occurred, i.e., the Asian financial crisis in 1997–1998 and the European sovereign debt crisis in 2007–2010. In the period of the Asian financial crisis, most sample countries (except for Indonesia in 1998) have real interest rates over the threshold (0.831%), which in turn leads to lower adjustment coefficients.

However, the real interest rates are lower in the period of the European sovereign debt crisis than the period of the Asian financial crisis. Several countries (e.g., China, Australia, Indonesia, Malaysia, and Singapore) even have the real interest rates below the threshold and higher adjustment coefficients. Thus, the influence of a specific financial crisis on the variation in adjustment coefficient is ambiguous. In fact, the Asian financial crisis led to a local disturbance and was accompanied with the situation of high nominal interest rate and low inflation rate. However, the European sovereign debt crisis caused a global impact and was associated with the state of low nominal interest rate and high inflation rate. That is, the macroeconomic characteristics of a specific financial crisis are more important for policymakers to evaluate its impact on the adjustment coefficients. From the estimation results in Eq. (8), one can trace similar dynamic processes. To save space, we omit the analysis.

Short run causality

According to the estimated coefficients $\sum_{k=1}^{4}\gamma'_{12k} = 0.4104$ in Eq. (8), the impact of the change in tourism receipts on the change in GDP enlarges as the real interest rate is above the threshold, 1.808%. Almost all the sample countries reveal this result during the period 1996–2003. Japan and South Korea even get this outcome in the entire sample period. Notably, in the periods of the US and European financial crises (2007–2010), the real interest rates are below the threshold in China, Malaysia, and Macao; therefore, the short run influence of tourism on GDP becomes smaller. That is, in the periods of economic recession, relatively low real interest rates make the short-run linkage between tourism and growth weaker. The reason is direct that most economic activities, including tourism, trade, and economic growth, are sluggish in the recession periods, which causes a weaker linkage between economic activities.

From the estimated coefficients $\gamma'_{221} + \gamma'_{222} + \gamma'_{224} = 0.6681$ in Eq. (9), the short-run impact of growth on tourism strengthens as the real interest rate is above the threshold, 0.831%. Even though the insignificant coefficient γ'_{223} is put into the summation, the short-run effect is still positive. Half of the sample countries, including Australia, Hong Kong, Japan, South Korea, and Thailand, display this

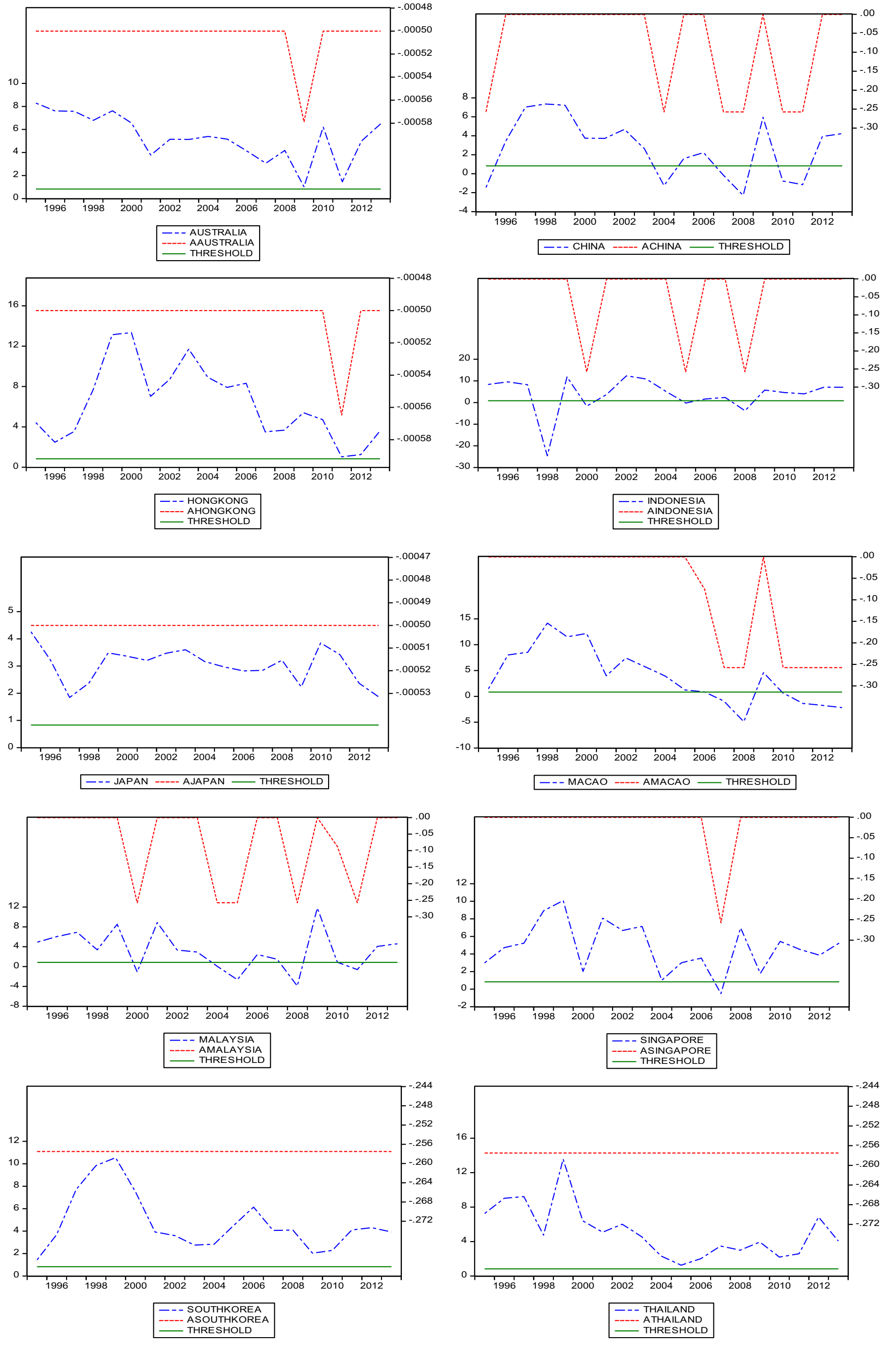

Fig. 1. Time- and country-varying adjustment coefficient, real interest rate and its threshold. *Notes*: THRESHODL denotes the threshold of real interest rate. The adjustment coefficient is measured in right vertical axis, and real interest rate and its threshold are measured in left right vertical axis (unit:%).The letter "A" added in front of the name of a specific country represents the country's adjustment coefficient.

characteristic in the entire sample period. In addition, during the periods of the US and European financial crises, the real interest rates are below the threshold 0.831% in China, Malaysia, and Macao SAR; therefore, the short-term effect of growth on tourism weakens. The reason is similar to the description mentioned above.

In sum, the short run causality and long run causality are bi-directional and vary with time and across countries, depending on the real interest rates in different regimes. A country's development level, macroeconomic conditions, and financial policies have profound influence on the causality.

Policy implications

Based on the above empirical results, this section provides some policy implications. First, the bi-directional link means that tourism and economic growth have a reciprocal causal relationship. Thus, national income can be used to improve the level of tourism infrastructure and sites that are available in these countries in order to attract tourist to their destination so that there will be an increase in the level of economic activities in the sector, which will thereby accelerate long-run economic growth (Kareem, 2013). That is, a reciprocal growth-tourism relationship implies that a push in these two areas would benefit both (Zortuk, 2009).

Second, the threshold in Eq. (8), 1.808%, is larger than that in Eq. (9), 0.831%, implying that the regime switching of the short run causality from growth to tourism occurs earlier than that from tourism to growth. That is, with the improvement of economic or business conditions, the real interest rates increase gradually, and the sample countries first face the increasing effect of growth on tourism and then the increasing impact of tourism on growth, in the short term. From the policy point of view, the policies that stimulate economic growth will be first adopted to increase tourism receipts in the short run. Once the tourism receipts are raised, they will generate a feedback effect to further augment the economic growth. However, when the real interest rate is above the threshold, 1.808%, the short run bi-directional causality between growth and tourism would be enlarged. Under this circumstance, the policies that are simultaneously beneficial to economic growth and tourism can be used for strengthening growth and tourism receipts.

Third, from the point of view of public policy, an expansionary monetary policy is generally regarded as a tool to stimulate a country's economic growth through the drop in nominal interest rate. However, it will reduce the real interest rate, which weakens the short run link of growth-tourism causality. That is, the influence of the lagged economic growth on current tourism receipts (or the lagged tourism receipts on current economic growth) becomes smaller. In this situation, governmental authorities need to adopt other auxiliary policies that can stimulate tourism (or economic growth) in order to compensate for the reduction of the short run contribution from growth to tourism (or from tourism to growth). For example, the authorities can employ subsidy policies to encourage domestic consumption and investment for promoting economic growth.

Fourth, the inflation-targeting regime has been a new framework in the monetary policy field since the early 1990's. Under this regime, stabilizing price levels becomes the key policy aim for the monetary authority. If monetary authorities attempt to depress the inflation rate under a specific level (for example, 2%), according to the definition of real interest rate, the real interest rate would rise. Under this circumstance, the results of the short run and long run causalities between growth and tourism are contrary to those obtained from adopting an expansionary monetary policy. Clearly, in the periods of high inflation rates (for example, in 2009 and 2010), reducing the inflation can increase people's real income, which further stimulates private consumption and economic growth, and raises the bi-directional causality between tourism and growth.

Finally, the sample countries can improve their performance of economic growth, not only through investing in the traditional sources of growth, including investment in physical capital, human capital, and research and development but can also apply the contribution of the tourism industry towards such economic growth. Regarding the promotion in the tourism industry or sector, the methods include improvements in infrastructure, marketing skills, resource allocation, and education for the work force.

In sum, the nonlinear and bi-directional link between growth and tourism is deeply influenced by macroeconomic environment and monetary policy in both the short run and long run.

Conclusion

The prospect of a nonlinear relationship between tourism and economic growth has emerged in the academic paradigm, and the tourism-growth literature has become increasingly open to the possibility of nonlinear relationships existing between the variables. However, the literature on the nonlinear causality between tourism and economic growth remains relatively limited.

This paper analyses the dynamic relationship between tourism receipts and economic growth. By applying the panel smooth transition vector error correction model, we explore whether tourism leads, on the long- and short-run, to economic growth, or, alternatively, economic expansion drives tourism growth, or indeed a bi-directional relationship exists between the two variables.

Our result shows that there exists a bi-directional causality between tourism and growth in both the short run and long run. However, the causality is nonlinear and varies with time and across countries, and depends on the level of real interest rates in individual countries for each period. High real interest rates are not favorable for economic growth and tourism receipts to quickly adjust towards their levels of long run equilibrium; however, it strengthens the short run effect from growth to tourism and vice versa. In addition, macroeconomic conditions and the corresponding executed policies play an important role in the bi-directional causality between growth and tourism.

Two empirical limitations can be further improved to investigate the robustness of the empirical results as the observations are sufficient. The first restriction is the trade-off between the number of countries and the length of time period. The second one is the ignorance of whether there exist the spatial spillover effects of the causality between economic growth and tourism activity among the sample countries.

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