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A nonparametric panel data model for examining the contribution of tourism to economic growth☆

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ABSTRACT

We apply a nonparametric panel data model with cross-sectional and time-varying coefficients to examine the relationship between tourist arrivals and economic growth in the Schengen area from 1995 to 2019. In contrast to the parametric models employed in other studies, our nonparametric model makes no assumption about functional form and, hence, allows us to model the relationship nonlinearly. We find that the tourism–economic growth relationship in the Schengen area is nonlinear and time-varying. While the relationship between tourism and economic growth was positive and significant during 1995–2003, it was negative and significant during the Global Financial Crisis (2007–2008) and the European recession of 2012–2013. One additional contribution of the study is the finding that total factor productivity (TFP) has been growing at 1.45% per year. The results also show that country-level TFP growth was disrupted during the aforementioned negative economic shocks.

1. Introduction

Tourism is a major economic sector worldwide. According to the World Travel and Tourism Council, the sector, with all effects (direct, indirect, and induced) counted, was responsible for 10.4% of global GDP and 10.3% of global employment in 2019.[1] These figures show some variation across regions. The contribution of tourism to GDP (employment) ranges from 7% (5.6%) in Africa to 13.7% (15.6%) in the Caribbean; in Europe, the number is 9.3% (9.9%).

The tourism-led economic growth hypothesis (TLGH) states that tourism contributes to economic growth through multiple channels. In particular, tourism is a source of foreign exchange earnings, infrastructure investment, employment, and positive economies of scale, thus reducing production costs for local businesses (see, for example, Antonakakis et al., 2015a).

Several studies have tested the TLGH. Examples published in the leading tourism journals in the last 5 years include Antonakakis et al. (2016, 2019), Chiu and Yeh (2017), De Vita and Kyaw (2016, 2017), Wu and Wu (2017), Liu and Song (2018), Dogru and Bulut (2018), Lin et al. (2019), Eyuboglu and Eyuboglu (2020) and Zuo and Huang (2018). Reviews of much of the literature, dating back to the seminal study by Balaguer and Cantavella-Jorda (2002), are contained in Brida et al. (2016a), Castro-Nuño et al. (2013), Ahmad et al. (2020), and Liu et al. (2022). With few exceptions, the literature suggests wide support for the TLGH. For instance, in a review of 95 peer-reviewed studies by Brida et al. (2016a), there was support for the TLGH in all but a handful of countries.

These studies, however, employ parametric models with restrictive functional form assumptions. A limitation of parametric models is that the estimates may be biased and inconsistent, due to misspecification if there is no exact prior knowledge of the functional form (Li et al., 2011). In particular, the relationship may not be linear. Nonlinearities can be introduced into the relationship by economic downturns in destination or source countries or by exogenous shocks, such as health scares, natural disasters, or terrorism in destination countries.

Several studies find that there are structural breaks in tourism and GDP (Lee and Chien, 2008; Lean and Smyth, 2009; Narayan, 2005; Smyth et al., 2009, among others), which are a source of complexity and nonlinearities. As a consequence, parametric models may not uncover the underlying relationship between economic growth and tourism, nor the manner in which the relationship has evolved over time. The idea that nonparametric methods might be useful in analyzing the relationship between economic growth and tourism has also been recognized by Brida et al. (2020).

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[1] These figures were obtained from the United Nations World Tourism Organization (UNWTO).

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Some studies employing parametric models to test the TLGH have recognized the possibility of instability and nonlinearities in the relationship between economic growth and tourism. One approach has been to include a squared term for tourism to capture nonlinearities in tourism (Adamou and Clerides, 2009; De Vita and Kyaw, 2016, 2017). Other studies have employed nonlinear cointegration and threshold models (Po and Huang, 2008; Chang et al., 2012; Deng et al., 2014; Wang, 2012; Phiri, 2015; Brida et al., 2015; Brida et al., 2016b; Chiu and Yeh, 2017; Zuo and Huang, 2018). Some studies have applied time-varying models (Antonakakis et al., 2015a,b; Arslanturk et al., 2011; Balcilar et al., 2014; Enilov and Wang, 2022) or time-varying copula functions (Pérez-Rodríguez et al., 2015). Yet other studies have employed smooth transition regression (Pan et al., 2014; Wu et al., 2016) or quantile regression (Shahzad et al., 2017). All these approaches, however, make assumptions about the functional form, and none have the flexibility to fully capture the complexities of the relationship between economic growth and tourism.

We address this gap in the literature by applying a nonparametric panel data model with cross-sectional and time-varying coefficients to examine the relationship between tourism and economic growth for 17 Schengen countries in Europe over the period 1995 to 2019. We also contribute to the literature on the TLGH by estimating the common trend and country-specific trends, which has not been done before. Our novel nonparametric cross-sectional and time-series varying coefficient model employs a local linear dummy variable estimation (LLDVE) method to estimate the trend and coefficient functions in a highly nonlinear fashion. The LLDVE method we employ builds on the ideas initially presented in Li et al. (2011) and Zhang et al. (2012) and recently developed by Silvapulle et al. (2017), Hailemariam et al. (2019), and Awaworyi Churchill et al. (2019) in the energy economics literature.

As pointed out by Fan and Zhang (2008), "the varying coefficient models are not stimulated by the desire of purely mathematical extension, rather they come from the need in practice". Many relationships in economics are dynamic and evolving, for which time-varying coefficient models instead of linear models would be more suitable. Time-varying coefficient model is especially suitable for modeling economic growth. Economies grow when capital and labor grow, but the contribution of capital and labor need not remain constant over time for reasons such as changes in technology and labor efficiency.

This nonparametric modeling approach, however, has never been employed in the tourism literature. We use a wild bootstrap method to generate the confidence intervals for the underlying trend and coefficient functions. In so doing, we relax the restrictive functional form assumptions in the existing literature testing the TLGH. Our approach has the advantage that it allows the common trend functions to evolve to capture common global shocks due, for instance, to economic recession or terrorism, while the cross-sectional and time-varying coefficient functions capture nonlinearities and heterogeneity across countries and time.

Our baseline parametric point estimates suggest that the relationship between tourist arrivals and economic growth in the Schengen area is positive and significant. Parametric point estimates average out over time, however, and do not capture relational nonlinearities or switching between periods of positive and negative associations between tourist arrivals and economic growth.

Our estimated nonparametric coefficient function for tourism suggests that the relationship between tourist arrivals and economic growth is highly nonlinear, being significantly positive between 1995 and 2003 but significantly negative during the 2007–2008 and 2013–2014 periods.

In summary, our study differs from similar studies in several ways. First, the methodology is different from the ones used in most of the literature, where several variants of the Granger causality methodology have been used. The use of a novel nonparametric varying coefficient model for the first time in the tourism literature is our most important contribution. This methodology has been successfully used in several papers in other fields. Second, our study differs from others in its conceptual framework. Most studies do not provide a theoretical discussion of the tourism–growth relationship or provide only a brief overview. Our discussion starts by drawing attention to the substantial multiplier effects of tourism reported in other studies, some of which are probably due to productivity gains. Although there is no direct evidence showing that tourism can yield productivity gains, we make a theoretical case that it does by drawing on the literature on the knowledge spillovers generated by exporters, FDI, and agglomeration. Third, our study also differs from others in its explanation of why the tourism–growth relationship is expected to be time-varying, which is largely missing in the literature. Fourth, our methodology lets us obtain findings on important variables, such as trend GDP, which is an important indicator of an economy's long-run growth potential.

The remainder of the paper is set out as follows. The next section provides a conceptual framework for the study. Section 3 outlines our data sources and goes through some important economic developments in Europe during the study period. We present our baseline parametric results, which serve as a benchmark for the nonparametric results, in Section 4. The nonparametric results are presented in Section 5. We present the implications of our findings in Section 6, followed by the Conclusions in Section 7.

2. Conceptual framework

2.1. Theoretical discussion

As mentioned in the Introduction, tourism's overall effect on the economy is large. These multiplier effects, which arise when tourism creates or increases demand for other sectors, are documented extensively in the tourism literature. One study on several EU countries finds that gross value added increases by an amount that ranges between 0.58 Euro to 1.26 Euro when tourist spending increases by 1 Euro (Figini and Patuelli, 2022). These multipliers are calculated using the Tourism Satellite Accounts; hence, they only account for direct and indirect effects. It is unclear to what extent these multiplier effects reflect productivity increases, but it is plausible to believe they are partially due to productivity increases. In this section, we discuss how and why tourism can affect productivity.

Our conceptual framework is based on the standard Cobb–Douglas production function model that is often used in the growth literature. We start with two inputs, capital and labor, and bring tourism into the model as a productivity-enhancing variable:

$$Y = AK^{\alpha}L^{1-\alpha},$$

where $A = ET^{\epsilon}$. In this representation, E is the autonomous component of total factor productivity (TFP)—e.g., technological progress—T is the number of tourist arrivals, and ϵ is the tourism elasticity of TFP (A). This equation makes it clear that in a given year, two countries with equivalent resources can have different levels of real GDP, with the one possessing the larger tourism sector achieving the highest level.

Our treatment of tourism, which is a form of service export, as one of the determinants of TFP, is consistent with the findings of many studies in the literature on the export–growth relationship. Exporters usually have higher productivity than nonexporters, which increases overall TFP and contributes to economic growth. The higher productivity of exporters is partly due to the economies arising from operating at a larger scale. The productivity of exporters is also higher because of the knowledge spillovers in the form of learning-by-exporting, for which the literature provides strong support (Keller and Yeaple, 2009, p.9). We could expect to see these spillovers arising in the tourism sector, as well. Businesses operating in the tourism sector have to compete with their international peers intensely, whose efficiency levels are likely to be very high, leading to an improvement in the quality of the services they provide (Jin, 2011).

Tourism sector also attracts abundant foreign direct investment that is likely to be more efficient than the domestic service providers. Hence, tourism sector productivity is likely to be higher than the productivity in other service sectors, if the share of FDI of the tourism sector in overall FDI is relatively high. FDI might indirectly affect the productivity of the sector by generating knowledge spillovers. Spillovers occur as workers move from foreign to domestic firms, through demonstration effects and horizontal linkages (between the firms that are in the same industry), and when domestic firms strive to compete with foreign firms (see Blomström and Kokko, 1998, for further details on the spillover channels). Evidence from other sectors show that these spillovers could be substantial. Keller and Yeaple (2009) find that the contribution of spillovers from the manufacturing FDI to the productivity growth in the US manufacturing industries during 1987–1996 was between 8% and 19%.

Consequently, the productivity in the tourism sector would probably be higher than that of the other (service) sectors, either because most of the sector's "output" is exported or because of the heavy presence of foreign firms. If this is the case, output in the sector will increase more than the decreased output in other service sectors as more resources are shifted to the tourism sector, increasing aggregate output. If the tourism sector is not more productive than the other service sectors, however, a rise in tourism output would be offset by reduced output in other sectors, creating "Dutch" disease problems.[2]

Tourism activities might improve productivity in other sectors through the input channel, which contributes to aggregate TFP. Many firms use at least some services as inputs. This provides an avenue for the services to increase the overall productivity level of the economy. Francois and Hoekman (2010) find evidence on this, and conclude that producer services are major contributors to the overall productivity growth in OECD and developing countries. Productivity improvements by service firms can improve the productivity of firms using their services and thus increase the competitiveness of those firms, leading to increased exports. Spillovers that arise as a result of any increase in exports this way would also be fed into the productivity.[3] If tourism could increase the efficiency of some of these inputs, the output or value added of the industries using these inputs would increase. For instance, carrying a lot of leisure travelers, who are mostly tourists, might also make airliners more efficient in the business travel segment, which in turn decreases the costs of businesses in all the other sectors.

Tourism could also boost aggregate TFP because the operation of highly productive domestic and foreign service providers might generate knowledge spillovers to other sectors in the economy through vertical linkages (the backward and forward linkages with the firms in related industries).[4] The magnitude of these spillovers from tourism to other industries would depend on to what extent technological knowledge, management, labor, and organizational practices of the tourism sector could be transferred to other sectors.

Faber and Gaubert (2019) mention several other channels through which spillover effects could arise. A higher level of tourism activity at a certain location could stimulate local credit and financial services growth, as well as other services such as accounting and consultancy, needed by businesses in that location. In addition, because of a larger local tourism sector, the training level of local workers could increase, business opportunities could increase and lead to new business ventures, and more people traveling across locations could help foster new networks (Faber and Gaubert, 2019, p.2274). These spillovers can have an impact on aggregate productivity if the productivity-boosting effects of tourism activities clustered in certain areas may not necessarily be limited to those areas but could spill over to other industries no matter their locations. Alternatively, if, as in Faber and Gaubert (2019), it is assumed that spillovers operate at the local level, then aggregate productivity would increase whenever positive changes in productivity in the areas where tourism activities cluster outweigh the possible negative changes in productivity in other areas.[5]

We see no reason why some spillovers, indeed most, should not occur at the aggregate level. Hence, our approach differs from Faber and Gaubert (2019) in assuming that productivity-boosting effects spill over to other industries no matter their location.

We can use the above equation to derive an equation that can be used in econometric estimations as follows:

$$\ln Y = \ln E + \varepsilon \ln T + \alpha \ln K + (1-\alpha) \ln L.$$

After adding control variables, an equation that can be used for final estimations is obtained:

$$\ln Y = \beta_0 + \beta_1 \ln K + \beta_2 \ln L + \beta_3 \ln T + \text{Control Variables} + u.$$

We use interest rate, consumer price index (CPI), exchange rate, and openness (trade as a percentage of GDP) as control variables. There is a large literature showing that trade and economic growth are related (see Singh, 2010, for a survey of this literature).[6] Interest rate, CPI, and exchange rate are included to control for the effects of monetary policy on economic growth. These also control for the macroeconomic instability, which at times heavily affected economic growth during the period under study.

2.2. Time variation

Time-varying methodology we use in this study implies that countries would have a higher real GDP in $t+1$ even if they used the same resources as they did in t, if the contribution of tourism (ε) were higher.

Time variation can arise in several ways. One reason is that changes in productivity in the tourism sector due to sector-specific technological shocks could increase ε. Another reason is that the share of activity generated by businesses owned and operated by foreigners change (FDI) in tandem with demand shocks to the tourism sector, increasing or decreasing spillover effects from these investments.

Nonlinearity in the tourism–GDP relationship, as found in some studies, can cause time variation. The basic idea is that if the relationship is nonlinear at any given point of time, when specific threshold of a certain variable, such as tourism specialization, is reached, the effect of tourism on economic growth will change, generating a time-varying relationship between the two variables. Similarly, structural breaks in the tourism–GDP relationship that some studies find might cause time variation, as well. (See the Introduction for a list of studies that find nonlinearity and structural breaks). For instance, the relationship may change after severe recessions, such as the Global Financial Crisis (GFC).

Suppose that elasticities do not change over time. Even in this case, output (GDP) shocks that differ in magnitude across countries would generate time variation in the tourism–real GDP relationship. As mentioned above, a large tourism sector benefits some industries, whose outputs or services are used as inputs elsewhere in the economy

[2] See Copeland (1991), Chao et al. (2006), and Inchausti-Sintes (2015).

[3] Hoekman and Shepherd (2017) find some evidence of both the direct and the indirect effect (through exports) of the services sector on productivity.

[4] For evidence of vertical spillovers in manufacturing industries through the backward and forward linkages, see Javorcik (2004).

[5] The argument in Faber and Gaubert (2019) for the existence of a long-run effect of tourism on productivity and growth is based on the concept of agglomeration effects. Agglomeration of tourism activities increases productivity in locations where this happens due to spillover effects on manufacturing firms in the same location. However, this attracts firms from other locations to the places where tourism activities agglomerate, leading to reduced productivity in those areas and suggesting an ambiguous effect overall (economy-wide).

[6] More recent evidence can be found in Chang and Mendy (2012), Dufrenot et al. (2010), Hye and Lau (2015), Kim (2011), Sarkar (2008), and Shahbaz (2012).

by making them more efficient. This could only benefit the industries where these inputs are used if they can maintain the same levels of revenues, in which case their value added would increase since their input costs would be lower. To explain how this can cause time variation in the tourism coefficient, assume an unexpected and negative output shock hits the economy, as in a recession. This would reduce the revenues of many firms and eventually affect their value added. If these shocks had higher magnitudes in countries with larger tourism sectors, their real GDPs would be much lower; consequently, the tourism coefficient would be negative.[7]

Within the empirical framework we use, another possibility is that the time variation in the tourism coefficient may be a result of time variation in the composition of demand. For example, certain segments, such as coastal and maritime tourism, might have different spillover effects on productivity than, say, mountain tourism. In certain years, the share of high-impact tourists might be overwhelmingly greater than the share of low-impact ones, which would be reflected in ε.[8] Some evidence indicates that the composition of tourism demand might matter. For instance, Tang and Tan (2015) show, using a recursive Granger causality test, that only arrivals from 8 of 12 markets contribute to growth because the number of arrivals from the other 4 markets may be insufficiently high or comprise mostly illegal workers rather than genuine tourists.

3. Data and economic background

3.1. Data

Named after the Schengen Agreement, the Schengen area consists of 26 European countries (22 of the European Union states and four other European countries), which have abolished their internal borders with other member countries. For tourists who need a visa to enter the European Union, the creation of the Schengen area has greatly simplified travel within Europe because it allows them to travel on a single visa or with a visa exemption (UNWTO, 2018).

We focus on the Schengen countries for several reasons. First, Europe generally, and the countries included in our sample particularly, are important destinations for tourism. Of the UNWTO regions, Europe accounted for the largest share of tourist arrivals, with 619 million tourists, or 50% of the world's total, in 2016 (UNWTO, 2018). It is estimated that tourism directly generates 5% of the European Union's GDP and that when indirect links are accounted for, tourism contributes over 10% of the European Union's GDP (UNWTO, 2018). For this reason, the European Union has placed much emphasis on tourism as an engine of economic growth, consistent with the TLGH (Antonakakis et al., 2015a).

The countries included in the sample are also similar in many other aspects, such as education levels and labor force participation rates. In short, they have similar levels of economic development. This may be important in obtaining more reliable estimates as the coefficients estimated using a set of countries with different levels of development may not be applicable to the developed ones.[9]

Another reason for the selection of these countries is that they have economies with a services sector larger than their manufacturing sector, which allows us to safely assume that the additional labor the tourism sector might need would be diverted from other services sectors. In economies with a large manufacturing sector but a small services sector, comprising mostly developing economies, additional resources would likely come from the more productive manufacturing sector.[10] This could lead to tourism becoming a "Dutch" disease.

We use annual data for 17 countries that are part of the Schengen area as of 2019.[11] In addition to real GDP (constant 2015 US dollars) and tourism arrivals, we collected data on real capital stock (gross fixed capital stock formation in constant 2015 US dollars), labor force, the CPI, the nominal exchange rate, population, and trade as a percentage of GDP. All data, except nominal exchange rates, come from the World Bank's World Development Indicators database. Exchange rates were obtained from the OECD website because pre-euro exchange rates, which were converted to euro/dollar exchange rates using a conversion factor, are available in the OECD dataset.

3.2. Economic background

The study period includes several years when economic activity slows down or contracts considerably. We trace out the effects of these booms and busts that occurred during the study period by analyzing the annual changes in the mean growth rates of real GDP and in the number of tourist arrivals obtained from the country-level growth rates in Fig. 1. The first such downturn occurred during the global economic slowdown of 2001, when the mean growth rate of real GDP dropped to 2.58% from 4.2% in 2000. As a result of the Global Slowdown, the mean growth rate of tourist arrivals also decreased to 0.83% in 2001.

The mean real GDP growth rate continued to drop until 2003, then started to increase until 2008, when the GFC hit. The most severe economic contraction occurred in the year following the GFC, with the growth rate turning negative at 4.72% in 2009. The mean growth rate of tourist arrivals bounced back to positive territory in 2002 and continued to increase until it peaked in 2004. As with the real GDP growth rate, the growth rate of tourist arrivals turned negative in 2009, with the arrivals decreasing at a rate of 3.29% from the previous year.

Although the economic growth started to accelerate in 2010, it slowed down again in 2012 because of the Euro Debt Crisis, dropping to almost zero in that year. Mean real GDP growth started to accelerate in the following year and remained above 2% from 2015 onward. Tourist arrivals increased by 13.13% on average in 2011. One reason for this is the recovery of the US economy following the GFC around this time. The United States is Europe's single biggest source of tourists (UNWTO, 2018). Another reason for the recovery in inbound tourism was the sharp increase in Chinese outbound tourists since 2009

[7] To illustrate, imagine a scatter plot that shows real GDP and tourist arrivals of 17 countries in logarithms in period t. Suppose a regression model fitted an upward-sloping line to these data, indicating a positive relationship between tourism and real GDP (countries with higher tourist arrivals have higher real GDP). However, percentage changes in real GDP (output) might differ across countries from one year to the next. If a sufficiently large number of countries that received large numbers of tourists in year t experienced larger decreases in their GDP than the countries that received smaller tourist arrivals in year t, the regression line would tilt down in $t+1$, that is, the slope (elasticity) would become negative.

[8] Time variation caused by changes in the composition of demand would disappear if the shares of various groups could be controlled for in the estimations using disaggregated arrivals data, which we do not have.

[9] Advantages of homogeneous samples have been noted by other authors, as well. See Sianesi and Reenen (2003), Madsen et al. (2018), and Yao et al. (2020).

[10] For the countries that are in our sample, gross value added of services as a percentage of total gross value added in 2020 is as follows: Austria (70), Belgium (77.4), Finland (69.4), Germany (69.8), Hungary (67.2), Iceland (72.6), Italy (73.9), Latvia (72.6), Luxembourg (87.3), the Netherlands (78.2), Norway (67.5), Poland (64.9), Portugal (75.3), Slovenia (64.6), Spain (74.8), Sweden (74.2), and Switzerland (72.6). These data come from Eurostat, accessed on May 22, 2023.

[11] The countries in our sample are (with the year of first implementation given in brackets) Austria (1997), Belgium (1995), Finland (2001), Germany (1995), Hungary (2007), Iceland (2001), Italy (1997), Latvia (2007), Luxembourg (1995), the Netherlands (1995), Norway (2001), Poland (2007), Portugal (1995), Slovenia (2007), Spain (1995), Sweden (2001), and Switzerland (2008).

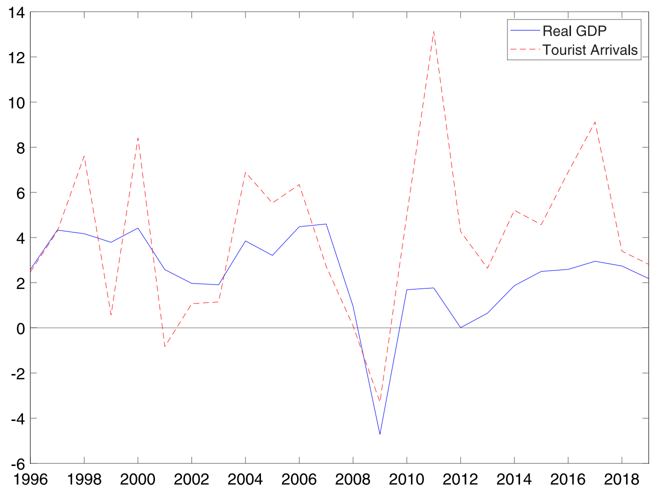

Fig. 1. Percentage changes in mean growth rates of real GDP and tourist arrivals, where mean growth rates are calculated from country-level growth rates.

(UNWTO, 2018). However, because of Europe's economic slowdown the following year, the mean growth rate dropped to 4.27% in 2012 and 2.64% in 2013. The mean growth rate of tourist arrivals accelerated again in 2014, continuing until 2017, when it peaked at 9.12%. In the final 2 years of the sample period, the mean growth rates were 3.4% and 2.81%, respectively.

This discussion and Fig. 1 clearly show that the mean growth rate of tourist arrivals was more volatile than the mean growth rate of real GDP in this period. Fig. 1 also shows that the mean growth rate of tourist arrivals was higher than the real GDP growth rate most of the time—16 of 25 years, to be exact.

4. Baseline parametric estimates

4.1. Empirical model

To examine the relationship between real GDP (denoted by GDP) and tourism, we use the following common correlated effects (CCE) model:

$$\ln \mathrm{GDP}_{it} = \alpha_i + \beta_i^{\top} X_{it} + u_{it}, \tag{1}$$

$$u_{it} = \lambda_{it}^{\top} f_t + \varepsilon_{it}, \tag{2}$$

for $i = 1, 2, \ldots, n$, and $t = 1, 2, \ldots, T$, where i denotes individual countries, and t denotes the tth time period. Eq. (2) includes time-varying common factors (f_t), which affect the dependent variable through country-specific factor loadings (λ_{it}). ε_{it} is a country-specific independent and identically distributed error term. X includes the following variables in natural logarithms: real capital stock, labor force, tourism as measured by number of tourist arrivals, CPI, nominal exchange rate, and trade openness (trade as a percentage of GDP).

One reason why we adopt a CCE estimation methodology in which cross-sectional dependence is handled by including common factors in estimations is that tourist arrivals and associated effects on GDP in any given country may affect other countries (particularly neighboring countries in Europe, as tourists may travel to more than one country), causing cross-sectional dependence among the countries. Another reason is that the economic crises in 1998, 2008, and 2012 are common factors. It is possible that these crises affected all countries in the sample through business cycle synchronization (Song et al., 2018).

We use the CCE mean group (CCEMG) and CCE pooled (CCEP) estimators developed in Pesaran (2015) to estimate the model. The CCEMG estimation is done by running a separate regression for each country with cross-sectional averages, which account for the factors that affect both the dependent and the independent variables included in the estimating equations. The average of the estimated coefficients (β_i) from country regressions indicates the effect of the independent variables on the dependent variable. The CCEP estimation is performed by pooling all data across countries; hence, the estimated slope coefficients are the same for each country. Country-specific fixed effects, and cross-sectional averages of each variable, including the independent variable, interacted with country-fixed effects are added to the estimating equations.[12]

Table 1
Pesaran's 2007 CIPS test for unit roots.

Number of lags	0	1	2	3	4
Specification without trend					
ln(GDP)	2.188	−0.379	−0.170	−1.314	−0.951
Δ ln(GDP)	−6.924***	−4.414***	−2.969***	−1.977***	−0.671
ln(Arrival)	−2.192**	−2.615**	−2.001**	−1.937**	−0.699
Δ ln(Arrival)	−8.587***	−6.052***	−2.004**	−2.497***	1.084
ln(CapitalStock)	2.433	1.337	0.827	1.893	−0.149
Δ ln(CapitalStock)	−9.091***	−5.777***	−4.575**	−0.627	0.926
ln(LabForce)	−1.310*	−1.664***	0.028	0.179	−0.852
Δ ln(LabForce)	−9.881***	−5.623***	−3.811***	−0.584	1.077
ln(CPI)	−2.519***	−2.104**	−0.641	−1.518*	1.390
Δ ln(CPI)	−7.001***	−2.922**	−2.543***	−2.500***	−1.985
ln(ExchangeRate)	0.154	−0.094	0.911	1.877	−0.367
Δ ln(ExchangeRate)	−12.404***	−7.75***	−4.022***	−15.863***	−1.580*
ln(Open)	0.758	0.236	0.408	−0.587	0.110
Δ ln(Open)	−8.947***	−4.267***	−0.841	−0.491	1.126
Specification with trend					
ln(GDP)	1.359	−1.631*	0.451	2.005	2.797
Δ ln(GDP)	−5.190***	−2.787***	−1.609*	−0.684	0.968
ln(Arrival)	−0.044	−0.629	1.425	1.661	2.090
Δ ln(Arrival)	−7.356***	−4.109***	0.381	−0.214	1.740
ln(CapitalStock)	−0.021	−0.791	0.944	3.021	2.647
Δ ln(CapitalStock)	−7.218***	−3.890***	−3.026**	0.110	2.868
ln(LabForce)	−0.528	−2.246**	0.734	2.796	2.315
Δ ln(LabForce)	−8.964***	−3.714***	−0.922	2.162	4.409
ln(CPI)	−1.590	−1.111	−0.646	−2.588	0.917
Δ ln(CPI)	−4.124***	−0.259	−1.026	−0.650	−0.009
ln(ExchangeRate)	−2.240**	−2.782**	−1.393*	−1.566*	−1.564*
Δ ln(ExchangeRate)	−10.238***	−5.666***	−1.353*	−3.654***	0.254
ln(Open)	2.519	1.984	2.032	1.756	2.253
Δ ln(Open)	−8.336***	−2.984***	0.369	1.146	3.319

Note: Null hypothesis is that the underlying series is I(1). CIPS test assumes cross-sectional dependence is in the form of a single unobserved common factor. Δ denotes first difference.

4.2. Empirical findings from parametric estimations

We start with cross-sectional dependence and panel unit root tests. We use the LM test proposed by Breusch and Pagan (1980) to test for cross-sectional dependence since the number of cross-sectional units (17) is smaller than the time periods (25).[13] LM test statistics are all significant at the 1% level, indicating that there is strong cross-sectional dependence in all the data series used in this study.

Given the evidence of cross-sectional dependence in all the data series, we proceed with the Pesaran's (2007) CIPS test for a unit root, which is robust in the presence of cross-sectional dependence. Results of the CIPS test with and without a trend are given in Table 1 and indicate that all series can be taken as $I(1)$.

The point estimates for the parametric model are given in Table 2. The tourism coefficient is positive and significant in both models. The

[12] We use the `xtcce` command in Stata to obtain the results reported in Table 2.

[13] According to Pesaran's (2015) CD test, the rejection of the null hypothesis, which is "errors are weakly cross-sectional dependent", implies strong cross-sectional dependence within the data series. The null hypothesis is rejected by the CD test for all series.

Table 2
Estimates of parameters for the parametric models.

Variables	CCEP ln(GDP)	CCEMG ln(GDP)
ln(Arrival)	0.0218**	0.0376**
	(0.0087)	(0.0181)
ln(CapitalStock)	0.154***	0.157***
	(0.0124)	(0.0165)
ln(LabForce)	0.332***	0.138
	(0.0672)	(0.0953)
ln(CPI)	−0.358***	−0.231***
	(0.0548)	(0.0841)
ln(ExchangeRate)	0.164***	0.149**
	(0.0285)	(0.0595)
ln(Open)	−0.0394	−0.0527
	(0.0282)	(0.0436)
Constant	7.708	5.292
	(6.462)	(3.463)
Observations	425	425
Number of countries	17	17

Note: Standard errors are in parentheses. Triple stars and a single star refer to significance at 1% and 10% levels, respectively.

coefficients for the CCEP and CCEMG models are 0.0218 and 0.0376, respectively. The significant coefficient for tourist arrivals implies that a 10% increase in arrivals is associated with 0.22 or 0.38% higher real GDP, depending on the model used. Other variables that are significant are real capital stock, exchange rate, and CPI when either estimator is used, and the labor force when the CCEP estimator is used.

The residuals obtained using the CCEP estimator can be used to check for cointegration among model variables (Holly et al., 2010). That is, the residuals are examined using the CIPS test to determine whether they are stationary. If they are found to be stationary, cointegration is indicated between the dependent variable and independent variables in the model. The CIPS test results show that the residuals obtained from the estimation are stationary up to four lags, indicating that there is cointegration between ln(GDP) and the independent variables included in the model.[14]

The parametric estimation methodology used here can capture the time-varying effect of common factors; however, the estimated coefficients are still time-invariant. We deal with this issue using the LLDVE method described in the next section.

5. Panel data model with time-varying trends and coefficients

5.1. Time-varying trend and coefficients

Let Y_{it} be the dependent variable and $X_{it} = \left(X_{it,1}, X_{it,2}, \dots, X_{it,k}\right)^{\top}$ be a vector k explanatory variables, for $i = 1, 2, \dots, N$ and $t = 1, 2, \dots, T$.

Li et al. (2011) proposed a fixed-effect panel data model with a common time trend and time-varying coefficients:

$$Y_{it} = f(t) + X_{it}^{\top}\beta_t + \alpha_i + u_{it}, \tag{3}$$

where $f(t)$ are unknown country-specific trend functions, $\beta_t = \left(\beta_{t,1}, \dots, \beta_{t,k}\right)^{\top}$ is an unknown vector of time-varying coefficients, α_i is an unknown individual effect, and u_{it} is stationary for each i. For the purpose of identification, it is assumed that $\sum_{i=1}^{N}\alpha_i = 0$ and that the time variable t is scaled by T, such that $f(t) = f(\tau_t)$ and $\beta_t = \beta(\tau_t)$, where $\tau_t = t/T \in (0, 1]$.

Li et al. (2011) proposed to estimate time-varying trends and coefficients using the LLDVE method, which is based on the following assumptions: (i) The error term u_{it} satisfies certain martingale difference conditions along the time dimension; (ii) e_{it} may be cross-sectionally dependent for each i and independent of X_{it}; and (iii) X_{it} and α_i can be correlated (see Silvapulle et al. (2017) and Hailemariam et al. (2019) for further explanation on the estimation and bandwidth selection).

Let $\hat{f}(\tau_t)$, $\hat{\beta}_t$ and $\hat{\alpha}_i$ denote the corresponding estimates obtained through LLDVE. Country-specific individual trends can be estimated in a similar way to what Zhang et al. (2012) do. We use $\hat{m}_i(\tau_t)$ to denote the estimates of these individual trends, and $\hat{u}_{it}$ to denote residuals.

5.2. Bootstrapping confidence intervals

A wild bootstrapping method is used to construct confidence intervals for the time-varying common trend and coefficient functions. Details of the bootstrapping procedure are as follows (see, for example, Wu, 1986; Mammen, 1993):

Step 1: Compute de-trended residuals $\hat{v}_{it} = \hat{u}_{it} - \hat{m}_i(\tau_t)$, where $\hat{u}_{it} = Y_{it} - \hat{f}(\tau_t) - X_{it}^{\top}\hat{\beta}_t - \hat{\alpha}_i$, for $i =, 1, 2, \dots, N$. Let $\hat{\boldsymbol{v}}_t = \left(\hat{v}_{1t}, \hat{v}_{2t}, \dots, \hat{v}_{Nt}\right)$.

Step 2: Resample the de-trended residuals $\hat{v}_{it}^{*} = \hat{v}_{it}\eta_{it}$, where η_t is chosen to be $-(\sqrt{5}-1)/2$ with a probability of $(\sqrt{5}+1)/(2\sqrt{5})$, and $(\sqrt{5}+1)/2$ otherwise. Generate a bootstrapping sample of Y_{it} through

$$Y_{it}^{*} = \hat{f}(\tau_t) + X_{it}^{\top}\hat{\beta}_t + \hat{\alpha}_i + \hat{m}_i(\tau_t) + \hat{v}_{it}^{*},$$

for $i = 1, 2, \dots, N$ and $t = 1, 2, \dots, T$.

Step 3: Based on the bootstrapped sample of $\{Y_{it}^{*}, X_{it}\}$, carry out LLDVE to obtain the estimates of the time-varying common trend $\hat{f}^{*}(\tau_t)$ and coefficients $\hat{\beta}_t^{*}$, as well as the individual trend $\hat{m}_i^{*}(\tau_t)$, for $i = 1, 2, \dots, N$ and $t = 1, 2, \dots, T$.

Step 4: Repeat **Step 2-3** for $B = 1000$ times and obtain the 90% confidence intervals for $f(\tau_t)$, β_t and $m_i(\tau_t)$, for $i = 1, 2, \dots, N$ and $t = 1, 2, \dots, T$.

Thus, we obtain the 90% confidence bands for the common trend function, coefficient functions, and country-specific individual trend functions.

5.3. Empirical findings from nonparametric estimation

5.3.1. Tourism coefficient

The tourism coefficient function is plotted in Fig. 2. The contribution of tourism to economic growth is positive and significant during 1995–2003. After increasing steadily from 1997 onward, it peaks around 2001 and then decreases until 2008. Tourism has a negative and significant effect on real GDP between 2007 and 2008 and again from 2013 to 2014. The tourism coefficient ranges between −0.05 and 0.05, with a mean value of 0.01. This indicates that the contribution of tourism to economic growth has been positive on average, but only for limited periods.

The average coefficient reported here, as well as the coefficient obtained using parametric methods, compares well with the coefficients reported in panel data studies using methodologies comparable to ours. Xia et al. (2021) finds a coefficient of 0.041 using the AMG estimator, implying that a 1% increase in the number of international tourist arrivals is associated with a 0.04% increase in real GDP per capita. The coefficient estimated by Fayissa et al. (2008), who study 42 economies in Africa in the period of 1995-2004, implies that 1% increase in tourism receipts is associated with a 0.03% increase in real GDP per capita). Proença and Soukiazis (2008) find that 1% increase in tourism revenues is associated with 0.026 percentage point increase in real GDP per capita in their study of Greece, Italy, Portugal and Spain for the years between 1990 and 2004.

Our findings can possibly be interpreted within the context of Faber and Gaubert (2019), who posit that tourism's contribution to aggregate

[14] We tested for cross-sectional dependence first using the LM test, which indicated cross-sectional dependence ($\chi^2 = 192$ and p-value = 0.0009), with the CD test of Pesaran (2015) indicating otherwise. The CIPS panel unit root test statistics, $\bar{z}_t$ for lags 0–4 range between −9.851 and −5.244 and are all significant at the 1% level. Maddala and Wu's (1999) panel unit root test statistics, χ^2, for lags 0–4 gradually decrease from 291.209 to 141.914 and are all significant at the 1% level.

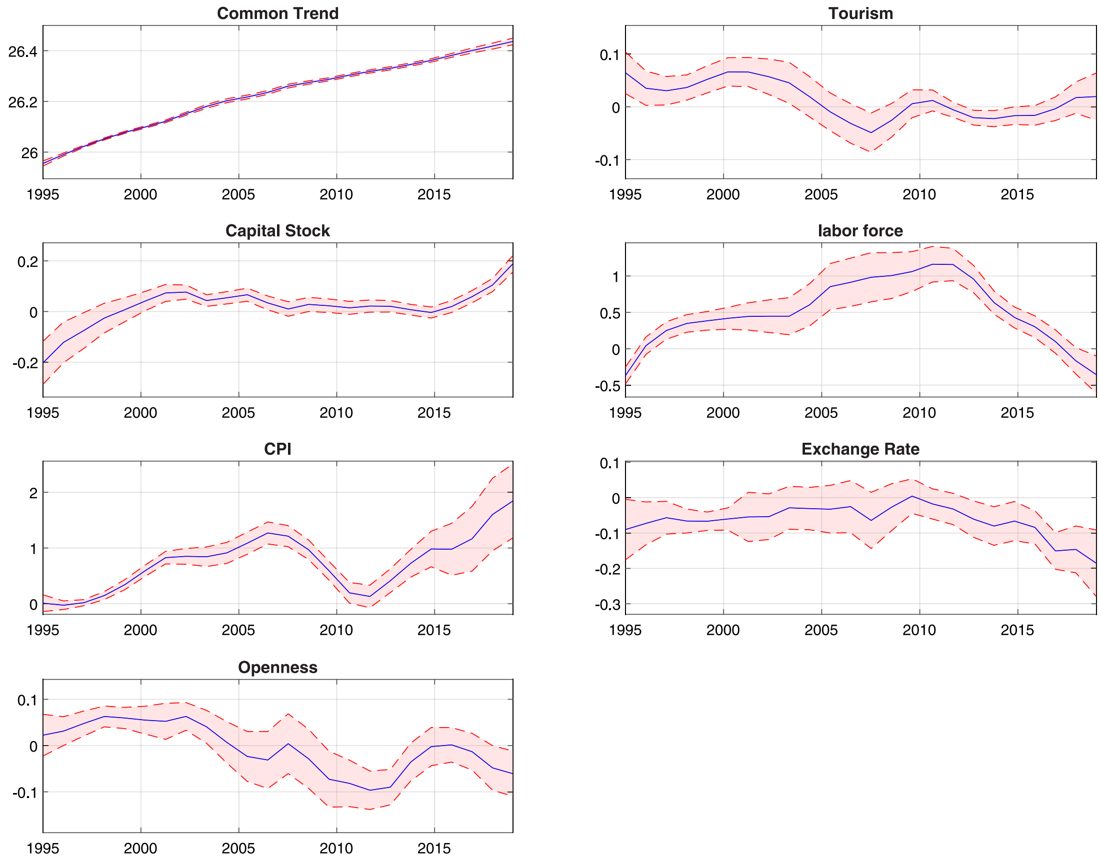

Fig. 2. Graphs of estimated common trend and coefficient functions.

economic growth may be ambiguous. Our finding of a positive average effect during 1995–2003 may suggest that, at least during this period, productivity-enhancing effects of tourism activities, where they cluster, are not offset by reduced productivity at other locations.

The negative coefficient we obtained for the period of GFC and the recession in 2013 is probably driven by cross-country heterogeneity in exposure to output shocks (how this could happen was explained in Section 2.2). In the conceptual framework above, a country with a larger tourism sector, as indicated by higher tourist arrival numbers, could end up with a lower real GDP than a country with a smaller tourism sector if the former experiences a more severe recession than the latter. The plots of common and country-specific trends in Fig. 3 clearly indicate the timing and the magnitude of these shocks.

Our finding of a time-varying coefficient aligns with the findings reported in several other studies. For instance, Antonakakis et al. (2015a) apply a time-varying model to examine the relationship between tourism and economic growth in Europe from 1995 to 2012 and find that the tourism–economic growth relationship is not stable and becomes highly unstable during periods of crises. The relevant crisis here is clearly the GFC, which slowed economic growth, as the tourism coefficient function bottoms out during the height of the crisis.

Arslanturk et al. (2011), using Granger causality methods, find that the time-varying effect of tourism (as measured by real tourism receipts) in Turkey was insignificant from 1963 to 1975, negative from 1976 to 1983, and positive thereafter. The same methodology has also been used in Balcilar et al. (2014) to examine the tourism–growth relationship in South Africa during the period of 1960–2011. The study finds that the effect of real tourism receipts on real GDP was positive except for the period of 1985–1990.

Chiu and Yeh (2017) apply a threshold regression model to examine the tourism–economic growth relationship in 84 countries. They find that if the threshold values are lower than certain optimal threshold values, then a significant negative tourism–growth relationship occurs. Economic crises contribute to nonlinearities and complexity. Hence, a feasible explanation for the negative relationship between tourism and economic growth during 2007–2011, in terms of the approach in Chiu and Yeh (2017), is that the GFC changed the optimal threshold values.

Wu et al. (2016) examine Granger causality between economic growth and tourism both in the short run and in the long run in Australia and nine countries located in Asia during the period of 1995–2013. The methodology they use is the panel smooth transition regression model with the real interest rate used as the threshold variable. They find bi-directional causality between the two variables that is nonlinear and varies with time and across countries, depending on the value of the threshold variable, the real interest rate.

Another study that looks into time variation in tourism–growth relationship is that of Liu and Song (2018), who use a rolling Granger causality test methodology to investigate the relationship between monthly visitor arrivals and quarterly GDP in Hong Kong between 1974 and 2016. Their analysis shows that the relationship between tourism and economic growth is unstable.

Shahzad et al. (2017) find that relationship between tourism–growth and growth in real GDP per capita in ten countries that they study is mostly positive. Contrary to what we find here, the relationship is found to be positive and especially pronounced during economic downturns. However, they also find that in a small number of countries, notably in China, the relationship between the two variables turns negative for some quantiles of economic growth.

5.3.2. Common and country-specific trends

The common trend function plotted in Fig. 2 shows that logarithmic real GDP in the Schengen area countries included in the study, which reflects the autonomous growth in the real GDP and/or the joint effects of possible omitted variables. From the figures in the plot, it can be

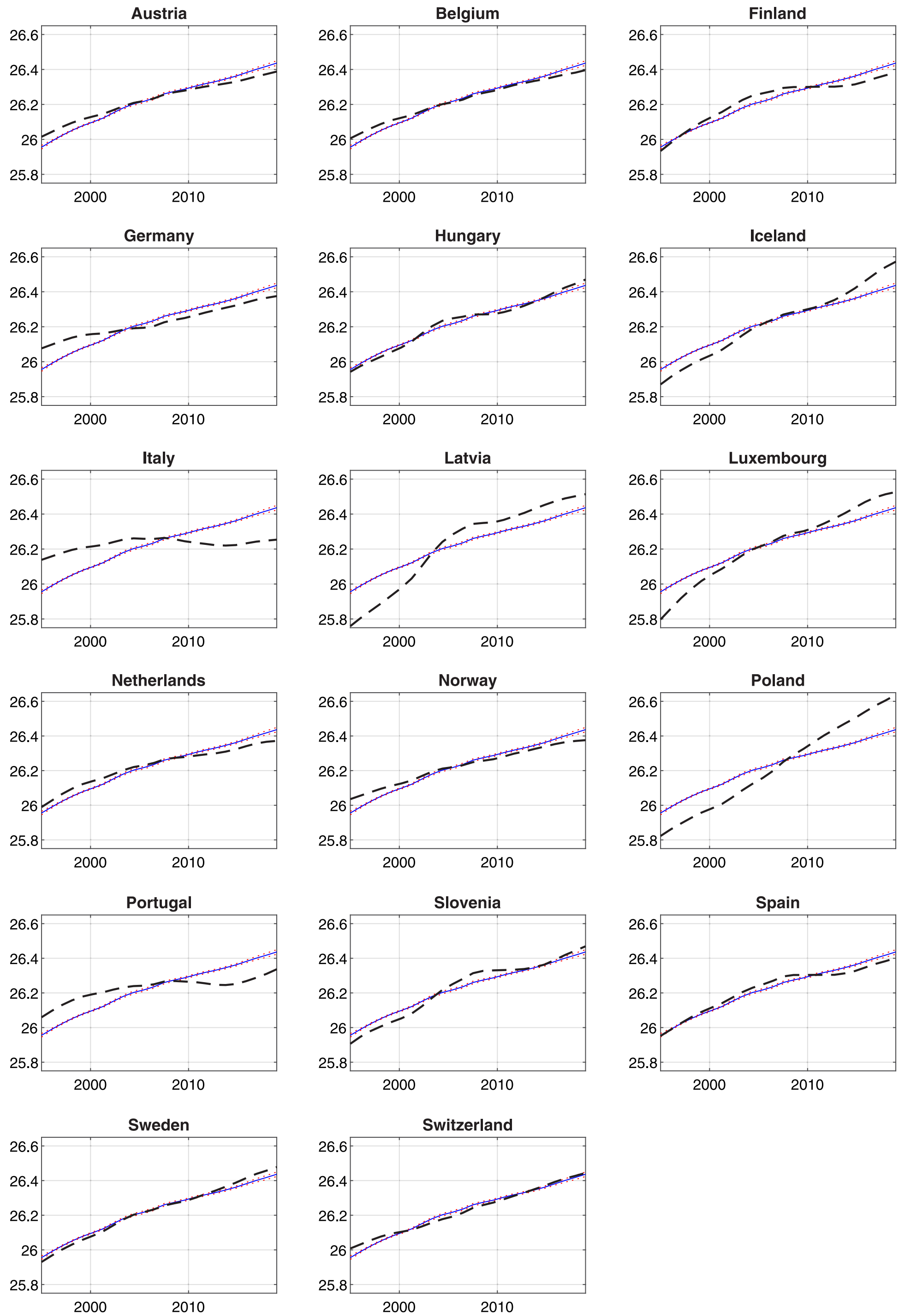

Fig. 3. Graphs of estimated country-specific individual trends.

calculated that during the 25 years of our study, real GDP increased autonomously or due to the effects of possibly omitted factors by approximately 43%, with annualized growth of around 1.45%.

The most salient aspect of the plot of the common trend function is that it exhibits a gradually increasing trend from 1995 to 2019, although the upward trend declines in 2000–2001 and again in 2013–2014. The slowdown in the first period was part of a global economic slowdown, attributable to higher energy and food prices, a downturn in the information technology sector, and declining consumer confidence. The slowdown in the second period occurred because of an economic slowdown in the Euro area.

Fig. 3 plots each country's specific trend, which was obtained by adding the country's individual trend to the common trend. A country's specific trend reflects the country's GDP growth pathway after accounting for the contributions of the six independent variables.

The graphs show that the specific trends of Sweden and Switzerland are nearly the same as the common trend. The specific trends of Austria, Belgium, Germany, Italy, the Netherlands, Norway, and Portugal are clearly above the common trend before the period of GFC and below the common trend thereafter. Specific trends of Iceland and Luxembourg are below the common trend before the GFC period and above

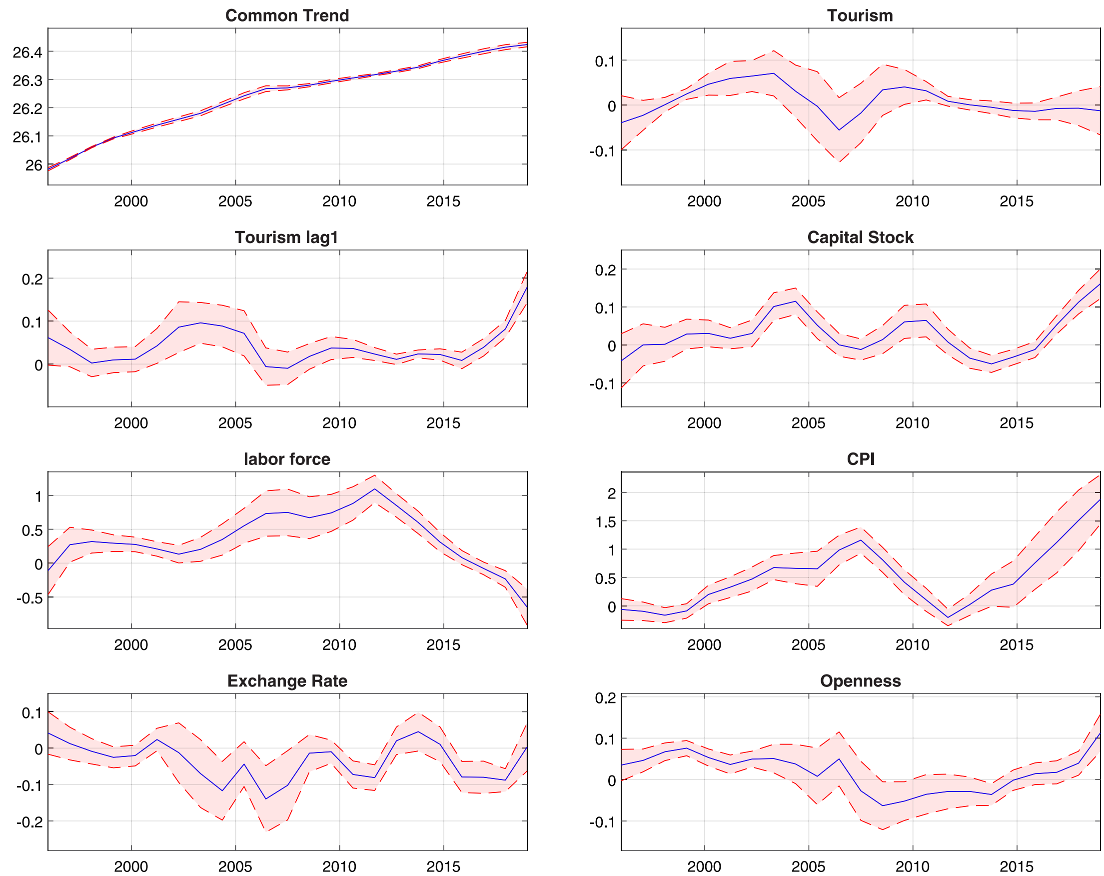

Fig. 4. Graphs of estimated common trend and coefficient functions with the lagged tourism being included.

afterward. Finland's and Spain's specific trends are above the common trend during the GFC period.

Specific trends of Hungary, Latvia, Poland, and Slovenia are below the common trend before 2004 and above afterward (with Poland's break in 2007). Hungary, Latvia, Poland, and Slovenia joined the European Union in May 2004 and have benefited from being European members since that date. Their specific trends are not adversely affected by the subsequent GFC and European debt crisis.

The analysis of these trends clearly shows that the 2008–2009 GFC had a major effect in most countries. It is also clear from the plots that the Eurozone debt crisis took its toll in most countries, excluding Iceland, Luxembourg, Sweden, Switzerland, and the four countries noted above. The effects of that crisis and the recession in 2013 appear to have been more severe in Italy and Portugal, which is not surprising as these countries were at the center of the debt crisis.

These plots support our conjecture that the sign of the tourism coefficient changed to negative during the two recessions that hit the economies under study based on the output shocks illustrated in the plots.

5.3.3. *Other variables*

The coefficient functions of the other variables are also plotted in Fig. 2. Real GDP is influenced negatively by real capital stock during 1995–1996 and positively between 2001 and 2007 and after 2016. The impact of capital stock has been increasing since 2016, becoming stronger after 2018. The labor force has a positive and significant effect on real GDP between 1996 and 2012. The effect turns negative and significant during the 2013–2017 period.

Trade openness is positive and statistically significant only between 1996 and 2003; since then, its effect has been negative and insignificant. The impact of the exchange rate on real GDP is negative and significant, except for the period between 1995 and 2001 and after 2013. The CPI coefficient is positive and significant most of the time, suggesting a positive association between the CPI and real GDP. The impact of the CPI on real GDP is positive until 2006, negative between 2007 and 2012, and positive again afterward. The negative relationship over the 2007–2012 period suggests supply shocks during this period, whereas the positive relationship during the Eurozone crisis indicates shocks on the demand side.

5.4. *Lagged effects of tourism*

As described above, tourism's contribution to long-term growth arises through several channels. Some of these channels might affect GDP with a lag. For instance, the effects of learning-by-exporting or learning-through-FDI can sometimes materialize with a delay. To check this possibility, we repeat the time-varying estimation with a lagged tourism term in the equations.[15]

The plot of the lagged tourism coefficient shown in Fig. 4 indicates that, from 2009 onward, the time-varying coefficient of lagged tourism is largely significant, whereas the time-varying coefficient of tourism is also significant during 2010–2011 but is insignificant after 2011. During the period before the 2008 crisis, lagged tourism was significant during 2002–2006, while tourism was significant during 1998–2004. The common trend, country-specific trends, and the time-varying coefficients of the variables other than tourism are largely the same as those in the original time-varying model (see Figs. 4 and 5).

Finally, we note that the lagged tourism coefficient is positive and significant for the recession years of 2009, 2012, and 2013, whereas the tourism coefficient is not. Compared with the coefficients obtained from the original model, this may suggest that the original estimates are

[15] We thank an anonymous reviewer for suggesting this method.

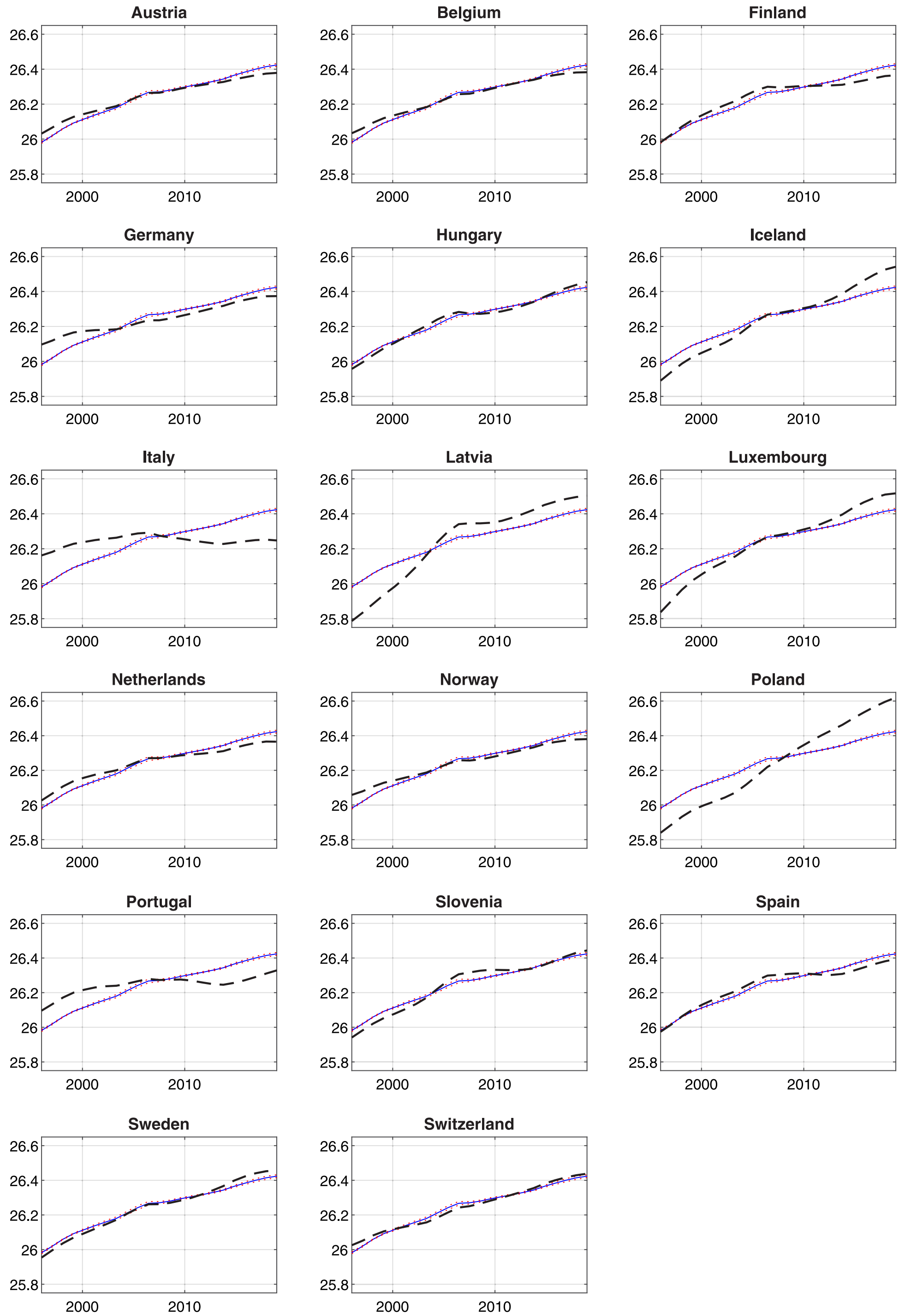

Fig. 5. Graphs of estimated country-specific individual trends with the lagged tourism being included.

biased upward. However, we do not think that the lagged effect could possibly be large enough to yield a positive coefficient in periods when the economy experiences severe output shocks, such as during the GFC and the Eurozone crisis. Hence, while it is obvious that tourism has a lagging effect, determining its size calls for more precise modeling of the issue.

6. Policy implications

Our finding that the tourism coefficient may make a positive contribution to economic growth and time-varying has several implications. The result, indicating a positive tourism–economic growth relationship, aligns with many studies finding that tourism contributes positively to economic growth. Therefore, we agree with these authors that it would be a good idea to make some effort to implement tourism development policies to sustain a large flow of tourism.

We mentioned above that it is possible that the aggregate productivity could increase as more resources are allocated to the tourism sector if the productivity in this sector is higher than that of at least some of the other service sectors. Governments can adopt policies that could help to increase tourism productivity. This could be achieved by putting policies in place to facilitate the adoption of new technologies in the tourism sector. These policies can be in the form of financial support schemes or programs that can increase the absorptive capacity of the service providers. Value added can also be increased by better training of employees to increase the service quality.

The segmented nature of the tourism demand suggests another way to promote tourism. Governments and businesses could try to identify those demand segments or markets (countries) that create larger effects first (for instance, these could be young travelers from countries with economies on an up cycle). Then they can concentrate their promotion and marketing efforts on these segments.

A related issue is that certain segments are seen as recession-proof. For instance, older travelers (retirees from developed countries, for instance) are usually considered recession-proof – that is, their numbers do not decline much during recession times – but going solely by numbers could be misleading since the spillover effects of certain groups could be lower than those of others. For instance, if the spillover effects generated by younger tourists, who tend to reduce their traveling during recessionary times, are higher than that of the older tourists, the net effect on productivity could be negative even if the numbers of older tourists did not change.

Some authors also suggest that tourism could act as a buffer during recessions and downturns. For instance, Shahzad et al. (2017) emphasize that when the tourism–economic growth relationship is nonlinear, policymakers should consider the specific phase of the economic cycle when designing tourism policies and that tourism-enhancing policies can be beneficial in periods of economic downturn.

Tourism promotion policies during recessionary periods can be of some help in stimulating the economy, but since recessionary shocks hit several sectors at the same time, expansion in tourism demand would not be enough to overturn the fall in output in other sectors.

The plots of country-specific trends show that some countries trend above the common trend, whereas others trend below it. Thus, those countries with below-average GDP trends might want to adopt aggressive tourism policies to promote economic growth during down cycles. Such an approach could create conflicts among EU member countries, however, and complicate the adoption of a common policy.

The growth in the trend real GDP can be interpreted as the growth in the autonomous TFP, which is not a function of tourism. Hence, it can be said that in the countries under study, TFP has been growing more than 1% a year during the period of 1995-2019 for reasons other than the growth in tourism. This is much higher than the efficiency enhancing effects of tourism that we mentioned above. Hence, to the extent this efficiency growth can be attributed to the growth in technology, it would pay off more to concentrate policy efforts on sustaining technological innovation, rather than promoting tourism. Since the trend real GDP continued to grow during GFC, this also could prove to be a more effective way of boosting the economy in times of recession.

7. Conclusions

A large body of literature examines the relationship between tourism and economic growth and specifically tests the TLGH. This literature has increasingly realized that the relationship between tourism and economic growth is nonlinear and unstable. However, existing studies that have employed parametric models to reflect instability and nonlinearities in the tourism and economic growth relationship are not flexible enough to truly capture the complexity of the underlying relationship. Our novel contribution has been to model the tourism–economic growth relationship in a nonparametric framework that provides a much better insight into the time-varying link between tourism and economic growth over time.

We have applied our nonparametric framework to model the relationship between tourism and economic growth in 17 Schengen area countries from 1995 to 2019. We find that while our estimated nonparametric coefficient function for tourism was positive and significant during the period of 1995–2003, it was negative and significant in 2007, 2008, 2013, and 2014. We also find that the relationship between tourism and economic growth is highly nonlinear, with the tourism coefficient function peaking in 1995 and 2001 and bottoming out in 2008 during the GFC. Our results are consistent with the view that crises can generate instability and nonlinearities in the tourism–economic growth relationship and even change the sign of the relationship for a limited period.

Policymakers might want to adopt policies to diversify demand in addition to conventional tourism promotion policies. To this extent, and considering that the categories of tourists, not just their numbers, might matter, it would be a good idea to analyze the tourism–growth relationship using tourism data disaggregated into several categories whenever possible, such as business versus leisure travelers.

Our results emphasize that policymakers should consider the time-varying link between tourism and economic growth when designing tourism policies. It has become almost accepted wisdom that the relationship between tourism and economic growth is positive. Our results suggest that this is generally the case for the group of countries included in this study, but there can be times when the relationship becomes unstable and even negative, particularly around times of crisis. Clearly, more research is needed to identify the nature and channels of productivity spillovers and how they change over time. Once this has been done, the time-varying nature of the tourism–growth relationship can be fully utilized.

Analysis of both the common and specific trend functions shows a common upward trend in real GDP, and country-specific trends diverge from the common trend asynchronously. This has several implications for tourism policy. First, these trends could be an indication of the substantial contribution of autonomous (independent of tourism) TFP to economic growth, as much higher than the contribution of tourism. Thus, directing policy efforts into enhancing TFP by other methods rather than through tourism development and promotion policies might be a better idea in the long run. Second, the asynchronous nature of country-specific trends might make it difficult to coordinate tourism policies, and indeed economic policies, among EU countries.

Our results illustrate the importance of looking at how a coefficient behaves in the short run to better understand the nature of the long-run relationship between two variables. The nonparametric time-varying methodology that we use in this study is an ideal tool for this. It can be used to check the stability of the coefficients obtained in an empirical analysis to ensure that they can be used to make policy decisions. There are other methods of dealing with time variation, but they are mostly Granger causality-type analyses or involve assumptions about the structure of the relationship under study. The nonparametric time-varying methodology we adopt here, which is somewhat easier to implement, can be used as an alternative to these other methods or could be used in combination with them.

Declaration of competing interest

We would like to confirm that the re-submitted manuscript is not subject to any conflict of interest.

Data availability

Code and data will be available upon request.

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