Environmental Science and Pollution Research
https://doi.org/10.1007/s11356-020-10375-1

RESEARCH ARTICLE

The role of tourism, trade, renewable energy use and carbon dioxide emissions on economic growth: evidence of tourism-led growth hypothesis in EU-28

Daniel Balsalobre-Lorente[1] · Nuno Carlos Leitão[2,3]

Received: 9 April 2020 / Accepted: 3 August 2020

Abstract
The article examines the effects of renewable energy, trade, carbon dioxide emissions and international tourism on economic growth in EU-28, considering panel data for the period 1995–2014. The investigation finds the new determinants of economic growth. The empirical results find support from the panel fully modified least squares (FMOLS), panel dynamic least squares (DOLS) and fixed effects (FE) as estimation techniques. The econometric results are consistent with the existing literature. The variables considered in this study are cointegrated in the first difference, as suggested by the panel unit root test. The present study seeks to advance the knowledge of the growth determinants, paying attention to the effect that both the tourism and energy sector exerts on economic growth for EU-28 countries. The empirical results demonstrate that trade openness, tourism arrivals and renewable energy encourage economic growth. Therefore, according to the econometric results, renewable energy allows improving environmental quality. However, CO_2 emissions are positively correlated with economic growth, showing that growth is directly correlated by climate change and greenhouse gas. The results also confirm the tourism-led growth hypothesis (TLGH) for the panel. Finally, the empirical results confirm that trade openness, energy use and international tourism contribute to enhance economic growth. Based on these findings, further insights and policy prescription are offered in the concluding section.

Keywords Tourism arrivals · Economic growth · Climate change · Renewable energy · Panel data

Introduction

Even previous empirical literature has supported a trade-off between economic growth and environment (Ulucak et al. 2020), our study presents hypotheses on the existence of a joined connection between sustainable growth, the promotion of renewable energy use and international tourism. The development of renewable sources is in line with the 2015 Paris Agreement, formalized by European Union's (EU) aimed to reduce emissions by at least 40% by 2030 (European Parliament 2016). So, our study tries to verify that the promotion of renewable energy is an efficient instrument to reach COP21 targets in EU-28. The favourable results would refuse the traditional trade-off between economic growth and the environmental correction process (Den Butter and Verbruggen 1994).

A meta-analysis on the theme of growth determinants shows that empirical studies have intensified and introduced new variables for the formalisation of this issue. Chirwa and Odhiambo (2018), Jambor and Leitão (2017) and Thorpe and Leitão (2014) demonstrated that the economic growth can be analysed by two different perspectives, i.e., exogenous category (e.g., Domar 1946; Solow 1956), and endogenous growth theory developed in the 1980s and 1990s, where Romer (1986), Lucas (1988) and Grossman and Helpman (1991) stand out that the theme of economic growth gains

Responsible Editor: Eyup Dogan

✉ Daniel Balsalobre-Lorente
Daniel.Balsalobre@uclm.es

Nuno Carlos Leitão
nunocarlosleitao@gmail.com

[1] Department of Political Economy and Public Finance, Economic and Business Statistics and Economic Policy, University of Castilla-La, Mancha, Cuenca, Spain

[2] Polytechnic Institute of Santarém, Center for Advanced Studies in Management and Economics, Évora University, Évora, Portugal

[3] Center for African and Development Studies, Lisbon University, Lisbon, Portugal

Published online: 17 August 2020

new support in the academic community. The endogenous growth theory introduced monopolistic competition hypotheses, such as innovation, human and intellectual capital, and the role of international trade on economic growth (Chirwa and Odhiambo 2018; Jambor and Leitão 2017).

As it will be possible to observe throughout this paper and especially in the presented empirical study, our study follows the endogenous growth theory. It assesses the complexity and possible connections between the impact of tourism arrivals, international trade and renewable energies on growth economic. Besides, the relationships between carbon dioxide emissions and economic growth from EU-28 countries are also considered.

This is on the premise that, since the middle of the last century, the tourism industry has emerged as a driving force of European economic systems. The promotion of effective policies would help to enhance sustainable tourism development across the EU member countries (Paramati et al. 2018). Therefore, EU-28 requires efforts to promote sustainable tourism development, investment in technology and effective tourism governance, increasing strategies aimed to promote tourism-related activities (Ferrer-Roca et al. 2020). Furthermore, the tourism industry has been identified as a growth propeller that allows the creation of new jobs, and consequently, tourist inputs contribute to the growth of the economies that receive tourism inputs (Brida et al. 2016a, Isik et al. 2018; Balsalobre-Lorente et al. 2020a). In consequence, for the analysis of these measures and the building of policy recommendations in a first step, our study tries to validate the existence of tourism-led growth hypothesis (TLGH) for EU-28 countries, where it also considered the role of dirty inputs, international trade and renewable energy, as additional driving forces of economic growth.

In this context, the data available for the year 2014 published by the World Tourism Organization (2018:56) show that tourism contributes to the economic growth of OECD countries with particular emphasis on Spain (10.9%), Portugal (9.2%), Mexico (8.7%), France (7.0%) and Italy (6.0%). Therefore, our paper assumes that tourism enhances economic growth (Balaguer and Cantavella-Jorda 2002), with induced effects on tourism-related activities (Balsalobre-Lorente et al. 2020b).

This ill antecedence is resonated in the report of the World Tourism Organization report (2018):13); with this crisis, in 2009, there was a decrease of − 4.3% in GDP. However, in 2010, the growth rate recovered and was positive again. According to the same source in 2012, there was a decrease of − 0.4%. In the following years, there was a significant improvement in growth rates, especially in the post-crisis years, to which the contribution of touristic activity owes much (World Tourism Organization 2018:13).

The effect of tourism arrivals on economic growth, tourism-led growth hypothesis (TLGH) has been studied by Castro-Nuño et al. (2013), Brida et al. (2016b) and Mitra (2019), among others.

We consider as independent variables, in the growth equation, international trade, foreign direct investment and tourism. Additionally it is important to mention the importance of studying the impact of carbon dioxide emission, considered as dirty input, and renewable energy emissions on economic growth. In the last decade, EU-28 went through an economic and financial crisis, which had negative impacts on the labour market and economic growth.

The intuition on the linkage between international trade and growth is considered in this article because international trade is an agent that promotes growth as documented by Frankel and Romer (1999), Dollar and Kraay (2004), Freund and Bolaky (2008) and Keho (2017). The oligopolistic market structure, the export of products differentiated by the quality, allows economies to gain advantages (Long and Miao 2019). Some studies conclude that increased exposure to trade reduces the risk of market distortions (Edmond et al. 2015).

There exists a flouring literature that highlighted the pivotal role of renewable energy which stimulates economic growth, via cleaner energies promoting sustainability development, and competitiveness (see Sebri and Ben-Salha 2014; Kahia et al. 2017; Soava et al. 2018; Zafar et al. 2019). For instance, Zafar et al. (2019) concluded that regulations in renewable energy are fundamental for sustainable economic growth. Soava et al. (2018) showed that renewable energy consumption has a strong positive impact on the eurozone's economic growth. More recently empirically, Ozcan and Ozturk (2019) explored the connection between renewable energy consumption and economic growth in 17 emerging countries from 1990 to 2016. The results confirmed that energy conservation policies present positive effects on economic growth. The study affirms that economic growth is associated with carbon dioxide emissions, greenhouse effects, climate change and environmental damage.

On the highlights above, this study assesses the relationship between renewable energies, tourism, carbon dioxide emissions and economic growth for EU-28 for the period 1995–2014. The current study also accounts for the impact of international trade on growth over the blocs studied. The distinction of this study to the extant literature is to arm policymakers and all stakeholders alike with ample insights into the theme for proper policy crafting. First, EU-28 countries are an exciting destination market from tourist attractions and have positive impacts on the economic growth of EU-28. Second, it evaluates the link between international trade and renewable energies and the effect of these variables on economic growth in a multivariate setting with the adoption of recent updated econometrics tools. Finally, the relationship between carbon dioxide emissions and economic growth was considered. Conclusively, studies of this kind are timely worthwhile given

global attention of government administrators on alternative economic growth catalyst.

The article is organized as follows. The "Literature review" section presents a literature review. The methodology is presented in the "" Data and econometric strategy" section. The empirical study is considered in the "Empirical results and discussion" section. The final section shows conclusions and some policy recommendations.

Literature review

This section presents the most relevant literature review to describe the linkage between renewable energy and economic growth. The nexus between tourism arrivals, carbon dioxide emissions (CO_2), trade openness and economic growth is also considered. We aim to present a survey on the recent literature review that assesses the complexity and connections between the impact of renewable energy, carbon dioxide emissions, tourism arrivals and trade openness in economic growth. We note that these explanatory factors of economic growth are disaggregated in the literature. Thus, this section aims to contribute to the literature review, since it groups the various explanatory factors and demonstrates the multiple possible links between them and the economic growth.

A substantial part of the literature analyses the relationship between tourism demand and economic growth (e.g., Jebli et al. 2015; Jambor and Leitão 2017; Alam and Paramati 2017; Amin et al. 2019; Mitra 2019; Shaheen et al. 2019; Balsalobre-Lorente et al. 2020a).

The study of Jebli et al. (2015) applied to the Tunisia experience for the period 1990 to 2010 used an ARDL model and Granger causality. The results prove that there is a unidirectional causality between tourism and income per capita. Moreover, the study presents a bidirectional causality between renewable energy and economic growth.

The study of Jambor and Leitão (2017) explains the correlation between tourism arrivals and growth-considered panel data (fixed effects) for the period 1995 to 2014 to Central and Eastern European countries. The authors selected as explanatory variables CO_2 emissions, international tourism arrivals, foreign direct investment and trade openness. The econometric results prove that international tourism arrivals promote economic growth, as well as trade openness and foreign direct investment. However, the empirical study of Jambor and Leitão (2017) found a negative correlation between CO_2 emissions and growth. Thus, the authors concluded that in this region, economic growth does not stimulate environmental damage.

The relationship among tourism sector and growth was considered by Alam and Paramati (2017) to the top 10 countries for the period 1995 to 2013, and they utilised it as econometric strategy FMOLS. The econometric results show that income per capita, trade openness and international tourism are positively correlated with tourism development. However, when the authors considered a second equation, it is possible to infer that population and income per capita present a positive effect on CO_2 emissions. Furthermore, the econometric model demonstrated that tourism arrivals and trade openness are negatively correlated with CO_2 emissions. Therefore, Lee and Brahmasrene (2013) explored the TLGH for European Union countries for the period 1988–2009. The empirical results revealed for panel data of EU countries a long-run equilibrium relationship among tourism, CO_2 emissions and economic growth.

The empirical study of Amin et al. (2019) to the South Asian countries for the period 1995–2015 demonstrated that there is a unidirectional causality between international tourism arrivals and economic growth, energy consumption and growth, and tourism and economic growth. In this context, the study of Mitra (2019) questioned if the tourism growth hypothesis (TLGH, tourism-led growth hypothesis) is valid; considering 158 countries, the author applied the proposal of panel causality of Dumitrescu and Hurlin (2012). The econometric results show that there is bidirectional causality between international tourism arrivals and economic growth. Besides, a meta-analysis allows concluding that a recent study (Tang and Tan 2017; Muhtaseb and Daoud 2017; Roudi et al. 2018; Tang and Ozturk 2017) found a positive correlation between tourism and economic growth, using different econometric estimators (time series and panel data).

Balsalobre-Lorente et al. (2020b) validated the TLFG for a panel of 25 OECD countries, concluding that both tourism and globalization enhance economic growth.

The linkage between tourism, energy, environmental and economic growth was investigated by Shaheen et al. (2019), using panel data for the period 1995–2016. The authors found support on the environmental Kuznets curve (EKC), and the study proves that tourism induces CO_2 emissions, and there is a relationship between economic growth and climate change. Hwang and Yoo (2014) concluded that energy conservation and CO_2 emissions cutback regulations found that policies to control CO_2 emissions should be established, taking into consideration the potential economic damage of such systems. Azam et al. (2016) explored the impact of CO_2 emission per capita on economic growth in China, the USA, India and Japan over the period between 1971 and 2013 were used. The empirical results showed that the impact of CO_2 emissions in the USA, China and Japan was positive, and it implied that these countries are either using green technology or implementing environmental regulation policies. By contrast, in the case of India, the results revealed a significant negative that indicates that India is yet not using green technology or infringing the environmental protection rules. In line with this finding, our study explores the connection between CO_2 and economic growth for EU-28.

Many studies considered the link between trade openness and economic growth (Grossman and Helpman 1991; Rebelo 1991; Dollar 1992; Frankel and Romer 1996; Thope and Leitão 2014; Zahonogo 2017; Mustafa et al. 2017; Ozatac et al. 2017; Chen et al. 2019; Çevik et al. 2019). These studies proved that international trade encourages economic growth. In general, the studies show that there is a positive effect of trade openness on economic growth.

The empirical study of Zahonogo (2017) examined the impact of trade openness on economic growth for 42 countries of sub-Saharan Africa for the period 1980–2012. The author uses a pooled mean group estimator, and the econometric results demonstrate that international trade promotes economic growth. In this context, Mustafa et al. (2017) show that trade stimulates human development and Asian economic growth. The authors also found that human development promotes economic growth.

Considering the autoregressive distributed lag (ARDL) model and vector error-corrected model (VECM) Granger causality to China, the experience was recognized by Chen et al. (2019). The authors demonstrate that trade is positively correlated with growth. Furthermore, renewable energy and trade present a negative correlation with CO_2 emissions.

The case of Turkey was investigated by Çevik et al. (2019), and the authors found that there is empirical support between trade and real economic growth, when they applied Granger causality techniques.

A vast literature review of growth also investigated the effects of renewable energy and carbon dioxide emissions on economic growth (e.g., Leitão 2014; Balsalobre-Lorente et al. 2018; Beer et al. 2018; Ntanos et al. 2018; Jebli et al. 2019; Sharif et al. 2019).

For instance, Sebri and Ben-Salha (2014) explored the linkage between economic growth and renewable energy consumption in the BRICS during 1971–2010. Kahia et al. (2017) explored the effects of renewable energy regulations on economic growth in MENA countries during 1980 and 2012. The results showed that the promotion of renewable energy generates positive impact on economic growth in MENA countries. Zafar et al. (2019) concluded that the promotion of innovations in renewable energy sectors would contribute to obtain ascending sustainable energy growth in Asia-Pacific Economic Cooperation (APEC) countries between 1990 and 2015. In the case of European countries, the connection between economic growth, CO_2 emissions, renewable energy and globalization was studied by Leitão (2014). Considering the Portuguese economy, this study proved that carbon dioxide emissions, renewable energy and globalization present a positive correlation with economic growth.

The empirical study of Balsalobre-Lorente et al. (2018) investigated the relationship between CO_2 emissions and economic growth, as well as renewable energy, trade and natural resources. The authors considered EU-5 countries (Germany, France, Italy, Spain and the UK) for the period 1985–2016, and they found that economic growth is associated with environmental damage. The variable of international trade presents a positive effect on economic growth and corroborates with the previous studies. Besides, Balsalobre-Lorente et al. (2018) suggested that the use of renewable energy consumption and natural resources allows contributing to environmental quality.

The study of Beer et al. (2018) investigated the link between renewable energy and the tourism sector. The article concluded that tourists consider more attractive the destination that uses eco-image, such as renewable energies, parks and plants. Tang et al. (2016) explored the linkage between tourism, economic growth and energy consumption in India, from 1971 to 2012. They concluded that policymakers should promote the tourism industry to enhance economic growth. Dogan et al. (2017) found that the promotion of energy efficiency and environmental regulations would expand the tourism industry and trading activities in OECD countries.

The cointegration between renewable energy and economic growth to EU 25 countries for the period 2007–2016 was investigated by Ntanos et al. (2018). The authors used as econometric strategy ARDL model, and the econometric results demonstrated that there is cointegration between renewable energy, non-renewable energy and economic growth in the long run. In this context, the empirical study of Jebli et al. (2019) considered a panel data applied for 22 Central and South American countries for the period 1995 to 2010. Using FMOLS and the DOLS cointegration estimator, the authors found that international trade, international tourism arrivals, foreign direct investment, economic growth and CO_2 emissions are cointegrated. The empirical results showed (Jebli et al. 2019) that renewable energy, tourism arrivals and foreign direct investment are negatively correlated with CO_2 emissions. However, international trade and income per capita present a positive effect on CO_2 emissions.

The connection between renewable energy and tourism for the case of China was considered by Sharif et al. (2019) to cover the period 1974–2016, and they concluded that tourism is associated with an increase of carbon dioxide emissions because tourism sector increases the use of energy. Isik et al. (2018) explored the linkage between tourism, renewable energy consumption and economic growth in China, Italy, Turkey, the USA, France, Spain and Germany. However, Sharif et al. (2019) also refer that the nexus between renewable energy and tourism allows decreasing the environmental damage.

Data and econometric strategy

The impacts of renewable energy, carbon dioxide emissions, trade openness and tourism arrivals on economic growth are

used in this study. As an econometric strategy, we use panel data to EU-28 for the period 1995–2014. The methodological sequence of this study proceeds on four routes; first, the investigation of stationarity properties to ascertain the maximum order of integration; second, exploring the equilibrium relationship among underlined variables; third, the long-run coefficient and magnitude of cointegration; and finally, detecting causality analysis by the Dumitrescu and Hurlin (2012) pairwise causality test.

Thus, this study considers the first step: the panel unit root test such as Levin et al. (2002), ADF-Fisher Chi-square and Phillips-Perron (Choi 2001) at in level, and first differences, as suggested in the literature (Balsalobre-Lorente et al. 2019; Apergis and Payne 2009), if the variables are not stationary at in level, we should apply the first differences and observe if the variables utilised in this study are cointegrated I (1). This is to avoid using variables integrated of order 2, which by extension translates to a spurious analysis.

To avoid spurious analysis from outlined variables given that most economic indicators are characterised by temporal inclinations that generate false inferences, as the initial phase, thus, the need to investigate the integration properties of the model parameters through the application of the Levin-Lin-Chu (LLC) (Levin et al. 2002), Augmented Dickey and Fuller-Fisher (ADF-Fisher) and Phillips-Perron (PP) (Choi 2001) unit root tests is pertinent.

On the one hand, ADF-Fisher and Phillips and Perron-Fisher (PP-Fisher) (Choi, 2001) unit root tests assume singular trend component, varying the autocorrelation terms for panel members; on the other hand, Levin-Lin-Chu (LLC) unit root tests admit conjoint trend component along cross-sections (Levin et al. 2002).

As previously outlined in the beginning section of the methodology, the current study applies two categories of panel unit root tests, namely (1) Fisher-ADF-Fisher and Fisher-PP-Fisher unit root tests accept firm restrictions that spontaneously change through the cross-section. The second category, (2) Levin-Lin-Chu (LLC) is based adopts strict limits that are unified through cross-sections, known as a standard unit root process while some literature considers that both Augmented Dickey-Fuller (ADF), and Phillips and Perron tests have low influence against the alternative of stationarity of the series for small samples, LLC (2002), panel-based unit root tests, and is considered more powerful than (1) unit root tests on individual time series. LLC (2002) boosts the degrees of freedom, lowering the collinearity between regressors. This LLC test also follows a normal distribution instead of non-conventional distributions, assuming homogeneity in the dynamics of the autoregressive coefficients for all panel members.

For our empirical method, once we have confirmed that selected variables are I~(1), we will agree with the null hypothesis in level, and the same will be discarded after a single derivative of the variables. The integrating order validates the cointegration bond amid them, considering that their direct permutation should be bound at the level. Following the econometric strategy, subsequently, the current study applied the panel fully modified least squares (FMOLS) and panel dynamic least squares (DOLS) proposed by Saikkonen (1991) and Stock and Watson (1993).

Panel data can also be estimated using three estimators: OLS, the fixed effects (FE) and the random effects (RE). The F statistical test determines the global adherence of the model. Moreover, the Hausman test checks the null hypothesis of random effects versus fixed effects (Arellano 2003). In this context, the fixed effects were also considered in this study to observe the estimators that have the same tendency between variables. The study uses as dependent variable income per capita, and the explanatory variables are renewable energy (RENW), carbon dioxide emission (CO_2), trade openness (TRADE), and tourism arrivals (TOUR). Subsequently, we proceed to our examination of the panel cointegration tests proposed by Pedroni, Kao, and Johnasen-Fisher cointegration tests, widely applied in the empirical literature, to determine the persistence of a cointegrating linkage amid selected model parameters. To validate this long-run linkage, we use the conventional Pedroni (1999) and Kao (1999) cointegration tests. Pedroni (1999) considers heterogeneous intercepts and drift constants through panel members. He puts forth seven estimations based on the assumption of the null hypothesis of the absence of a cointegrating association. We classify these tests in two groups: (1) "within dimension" tests that involve four residual tests (panel v-statistic, panel rho-statistic, panel PP-statistic, panel ADF-statistic), known as the panel cointegration statistics; (2) "between dimension" tests (group rho-statistic, group PP-statistic and group ADF-statistic) is known as the group mean panel cointegration statistic. In both cases, Pedroni (1999) assumes that the asymptotic distribution for both groups are normal.

Furthermore, in our empirical analysis, we use additional cointegration assessments. Prime of the lot is the Kao (1999) test that is founded on the Engle-Granger bi-period routine, and levies cross-sectional homogeneity.

The present study proceeds to investigate for a long-run connection and magnitude among selected model parameters, trying to validate the existence of TLGH for selected countries, applying panel cointegration tests. To achieve this, fully modified ordinary least squares (FMOLS) and dynamic ordinary least squares (DOLS) regression tests are used as estimation techniques to find out the long-run connection between variables.

We apply Dumitrescu and Hurlin (2012) test as an extension of the conventional Granger causality approximation, for detecting causality direction admits selected model parameters. Dumitrescu and Hurlin (2012) pairwise causality test provides more flexible results for small samples and under the existence of heterogeneous and unbalanced panel data and cross-sectional dependency.

Finally, once we have determined a cointegrating association among choice model parameters, long-run factors should be traced by means of cointegration estimators. Procedural schema of our paper considers FMOLS and DOLS estimators, as they provide efficient normal distributed estimators that correct endogeneity amid the model parameters along with the existential serial correlations in stochastic error. Both methods can control panel heterogeneity (Dogan and Seker 2016), being these techniques optimal for small samples (Narayan and Narayan 2005). Endogeneity bias and serial correlations are corrected by FMOLS and DOLS techniques and thus these estimators' sanction ordinary, normal extrapolation (Carlsson et al. 2007). FMOLS methodology works with non-parametric controls to manage endogeneity. This method is suitable in the presence of the cointegration of panel data analysis, correcting endogeneity bias, serial correlation and simultaneous bias (Hamit-Haggar 2012). On the other hand, DOLS applies Monte Carlo simulations to eradicate endogeneity through a parametric approach, considering lags-leads of model parameters (Kao and Chiang 1998). DOLS is a parametric model where lagged first-differenced coefficients are estimated explicitly. The errors are extended with lags, leads and contemporaneous values of the variables by employing DOLS (Yorucu and Kirikkaleli 2017). DOLS also considers the existence of cross-sectional dependence grounded on nation-explicit constants, generating unbiased, consistent and robust estimates. In consequence, the DOLS technique is more efficient than FMOLS for small samples.

Based on the literature review, we consider the following hypotheses:

H1: Cleaner energies contribute to more sustainable economic growth and the quality of the environment in EU-28.

The use of energy is necessary for any economic activity. Thus, for several years, economists have tried to test the relationship between energy consumption (non-renewable energy) and economic growth. The literature on this link is extensive and very rich.

Recent studies consider that the use of renewable energies leads to better energy efficiency and, consequently, to more sustainable economic growth. On the other hand, the energy issue, namely renewable energies, has received the attention of the international community (Kyoto Protocol 1997; UNFCCC 2015 agreements), intending to reduce environmental damage, more specifically climate change and greenhouse effects. With the formulation of this hypothesis, we think to find a positive correlation between renewable energies and European economic growth.

The studies by Balsalobre-Lorente et al. (2018), Beer et al. (2018) and Sharif et al. (2019) give support to the formulated hypothesis.

H2: There is a positive relationship between carbon dioxide emissions and economic growth in EU-28.

The literature demonstrates that there is a link between carbon dioxide emissions and economic growth. The production and processing of raw materials lead to an increase in climate change and, consequently, to environmental damage. Shaheen et al. (2019), Ntanos et al. (2018) and Alam and Paramati (2017) found a positive relationship between carbon dioxide emissions and economic growth.

H3: International trade stimulates and economic growth.

The cointegration between trade openness and growth has long been studied. Proponents of free trade and new theories of trade based on monopolistic competition, product differentiation, innovation and economies of scale consider that international trade is a promoter of economic growth. In this context, we expect a positive effect between the degree of openness and economic growth. The studies by Grossman and Helpman (1991), Rebelo (1991), Dollar (1992), Frankel and Romer (1996), Thope and Leitão (2014), Zahonogo (2017), Mustafa et al. (2017), Chen et al. (2019) and Çevik et al. (2019) found a positive effect of international trade on economic growth.

H4: Tourism is directly related to economic growth.

A vast literature also supports this relationship, tourism-led growth hypothesis (TLGH), as it is referred to by the empirical research, the tourism activity, and promotes employment and economic growth in a destination market. Thus, tourist arrivals contribute to economic growth. The empirical studies by Mitra (2019), Tang and Tan (2017), Muhtaseb and Daoud (2017), Roudi et al. (2018) and Tang and Ozturk (2017) found a positive effect of tourist arrivals on economic growth.

Considering the studies of Mitra (2019), Tang and Tan (2017), Tang and Ozturk (2017) and Jambor and Leitão (2017), the following function is used:

$$\mathrm{GDP} = f\left(\mathrm{RENW}, \mathrm{CO}_2, \mathrm{TRADE}, \mathrm{TOUR}\right) \tag{1}$$

$$\mathrm{GDP} = \beta_0 + \beta_1 \mathrm{RENW} + \beta_2 \mathrm{CO}_2 + \beta_3 \mathrm{TRADE} + \beta_4 \mathrm{TOUR} + \varepsilon_{\mathrm{it}} \tag{2}$$

where the dependent variable GDP represents the logarithm of gross domestic product per capita expressed in US dollars, from the World Bank (2019). All variables are expressed in logarithmic form.

The explanatory variables considered are the following:

RENW - Logarithm of a percentage of renewable energy in total final energy consumption. The source of this

proxy is the World Bank Indicators (2019). The data from Malta is not available from 1995 to 2001.
CO_2 - Logarithm of carbon dioxide emissions expressed in kilotons from the World Bank.
TRADE - Logarithm of exports of goods and services in the percentage of GDP from the World Bank, and OECD Nation accounts.
TOUR - Logarithm of the number of arrivals, overnight visitors from the World Bank and the World Tourism Organization. Based on database of the World Bank, the data are available from 1995. For this variable, the data for 1995 to Denmark and France is not available.
εit - it is the error term.

Table 1 displays the variables and the expected signs considered by the literature review to independent variables.

Empirical results and discussion

Table 2 presents the descriptive statistics for the variables used in this paper. The variables tourism arrivals (TOUR), carbon dioxide emissions (CO_2) and income per capita (GDP) present the higher values of means. Besides, the variables of tourism arrivals (TOUR), carbon dioxide emissions (CO_2) and income per capita (GDP) are the higher values of maximum.

Table 1 Definitions of variables

Dependent variable		Source
GDP- Income per capita based on purchasing power parity (PPP)		World Bank: World Development Indicators (2019), and OECD (2019) National Accounts.
Explanatory variables	Expected signs	Source
RENW- Share of renewable energy (proxy of clean energy input)	[+]	World Bank: World Development Indicators (2019), and International Energy Agency (2019)
CO_2- Carbon dioxide emissions (proxy of dirty energy input)	[+]	World Bank: World Development Indicators (2019)
TRADE- Exports of goods and service in percentage of GDP	[+]	World Bank: World Development Indicators (2019), and OECD (2019) National Accounts.
TOUR-Tourism arrivals (proxy of tourism)	[+]	World Bank: World Development Indicators (2019), and World Tourism Organization (2019).

All variables are presented in logarithm form

Source: Authors composition

Table 2 Descriptive statistics

Variables	Mean	Std. Dev	Min	Max
GDP	4.360	0.238	3.726	5.006
RENW	0.963	0.456	−1.059	1.698
CO_2	4.759	0.614	3.315	5.949
TRADE	1.669	0.220	1.155	2.328
TOUR	6.759	0.545	5.706	7.923

All variables are presented in logarithm form

Source: Authors calculation considering the World Bank Indicators database (2019)

The correlations considered in this investigation are presented in Table 3. The independent variables show a positive effect on economic growth (income per capita, GDP). However, renewable energy (RENW) has a negative impact on economic growth. The renewable energy (RENW) is negatively associated with carbon dioxide emissions (CO_2), trade openness (TRADE) and tourism arrivals (TOUR). As well, the carbon dioxide emissions (CO_2) present a negative correlation with trade openness (TRADE) and positively correlated with tourism arrivals (TOUR).

The panel unit root test suggested by Levin et al. (2002), ADF-Fisher Chi-square and Phillips-Perron (e.g., Choi 2001) is reported in Table 4. The results show that all variables are cointegrated at first difference.

Table 5 presents the results of the Pedroni panel cointegration test and the Kao residual cointegration test. Based on the results, we can infer that the variables used in this research are cointegrated in the long run.

Table 6 reports the econometric results with FMOLS and DOLS cointegration estimators. All independent variables, renewable energy (RENW), carbon dioxide emissions (CO_2), trade openness (TRADE) and tourism arrivals (TOUR), are statically significant at a 1% level with the expected sign. The econometric results are similar between FMOLS and DOLS, and they present the expected signs proposed by the empirical literature. As all variables are in logarithm form, the estimates can be reading by elasticities.

Table 3 Correlation between variables

Variables	GDP	RENW	CO_2	TRADE	TOUR
GDP	1.000	-	-	-	-
RENW	− 0.131	1.000	-	-	-
CO_2	0.139	− 0.106	1.000	-	-
TRADE	0.327	− 0.293	− 0.589	1.000	-
TOUR	0.277	− 0.045	0.833	− 0.579	1.000

All variables are presented in logarithm form

Source: Authors calculation considering the World Bank Indicators database (2019)

Table 4 Panel unit root

	(A) Null: unit root (assumes common unit root process)		(B) Null: unit root (assumes individual unit root process)			
	Levin, Lin and Chu t		ADF - Fisher Chi-square		PP - Fisher Chi-square	
	t statistic	Prob.	*t* statistic	Prob.	*t* statistic	Prob.
At level						
GDP	12.425	(1.000)	1.0315	(1.000)	0.078	(1.000)
RENW	6.974	(1.000)	8.151	(1.000)	6.474	(1.000)
CO_2	− 5.576***	(0.000)	88.144***	(0.004)	92.201***	(0.001)
TRADE	5.294	(1.000)	6.994	(1.000)	5.086	(1.000)
TOUR	8.37636	(1.000)	3.43880	(1.000)	2.65258	(1.000)
At first difference						
ΔGDP	− 6.414***	(0.000)	97.252***	(0.000)	124.234***	(0.000)
ΔRENW	− 9.368***	(0.000)	198.734***	(0.000)	337.128***	(0.000)
ΔCO_2	− 13.330***	(0.000)	263.509***	(0.000)	479.674***	(0.000)
ΔTRADE	14.234***	(0.000)	267.668***	(0.000)	390.519***	(0.000)
ΔTOUR	− 12.628***	(0.000)	231.187***	(0.000)	316.735***	(0.000)

All variables are presented in logarithm form. Statistically significant at 1% level (***)

Source: Authors calculation considering the World Bank Indicators database (2019)

The variable of renewable energy (RENW) presents a positive impact on economic growth ($\beta_1 > 0$), proving that renewable energy stimulates sustainable development. Thus, an increase at 1% of renewable energy (RENW) encourages and increases economic growth of 0.1412% (FMOLS estimator) and 0.236% (DOLS estimator). Sharif et al. (2019), Jebli et al. (2019), Balsalobre-Lorente et al. (2018) and Beer et al. (2018) also found a positive correlation between renewable energy (RENW) and economic growth (GDP), thus validating the pivotal role of clean energy to economic growth.

The coefficient of carbon dioxide emissions (CO_2) is positively correlated with economic growth ($\beta_2 > 0$), showing that climate change and environmental damage are associated with economic growth. The empirical studies of Shaheen et al. (2019) and Ntanos et al. (2018) give support to our result.

The variable of trade openness (TRADE) presents a positive effect ($\beta_3 > 0$), on economic growth. According to H3, international trade promotes economic growth. The studies of Grossman and Helpman (1991), Frankel and Romer (1996), Thorpe and Leitão (2014), Zahonogo (2017), Mustafa et al. (2017), Chen et al. (2019) and Çevik et al. (2019) also found a positive correlation between trade and economic growth.

As in the empirical studies (Mitra 2019; Tang and Tan 2017; Muhtaseb and Daoud 2017; Roudi et al. 2018, and Tang and Ozturk 2017), our result for tourism arrivals promotes economic growth ($\beta_4 > 0$), validating the TLGH for EU-28.

Table 7 shows the econometric results with the fixed effects. The Hausman test assesses the null hypothesis of random effects (RE) versus fixed effects (FE). According to our estimates, the random effects estimator (RE) is excluded. On the other hand, our sample data is not random. Furthermore, the F statistic test shows that our model is globally robust. Moreover, the fixed effects model was estimated using White's command to correct heteroscedasticity and endogeneity among the variables used in the regression (e.g.,

Table 5 Panel cointegration tests

Pedroni cointegration test				
Within dimension				
			Weighted	
	Statistic	Prob.	Statistic	Prob.
Panel v-statistic	21.045***	(0.000)	16.792***	(0.000)
Panel rho-statistic	4.788	(1.000)	4.316	(1.000)
Panel PP-statistic	1.491	(0.932)	− 0.057	(0.477)
Panel ADF-statistic	− 1.960**	(0.025)	− 4.164***	(0.000)
Between dimension				
	Statistic	Prob.		
Group rho-statistic	6.145	(1.000)		
Group PP-statistic	− 3.301***	(0.000)		
Group ADF-statistic	− 4.119***	(0.000)		
Kao residual cointegration test				
	t statistic	Prob.		
ADF	− 4.225***	(0.000)		
Residual variance	0.000			
HAC variance	0.001			

Statistically significant at 1% (***), 5% (**) and 10% level (*)

Source: Authors calculation considering the World Bank Indicators database (2019)

Table 6 Panel fully modified least squares (FMOLS) and panel dynamic ordinary least squares (DOLS)

Dependent variable GDP Variables	FMOLS Coef.	DOLS Coef.	Expected Signs
RENW	0.1412*** (0.000)	0.236*** (0.000)	[+]
CO_2	0.375*** (0.000)	0.687*** (0.000)	[+]
TRADE	0.692*** (0.000)	0.819*** (0.000)	[+]
TOUR	0.619*** (0.000)	0.403*** (0.000)	[+]
Obs	523	457	
Adj R^2	0.90	0.95	
S.E. of regression	0.073	0.051	
Long-run variance	0.012	0.000	
Mean dependent var	4.373	4.375	
S.D. dependent var	0.233	0.23	
Sum squared resid	2.596	0.27	

Source: Authors calculation considering the World Bank Indicators database (2019)

Dependent variable: logarithm of income per capita (GDP). All variables are presented in logarithm form. Statistically significant at 1% (***) level

White 1982, 1984). The results are very similar to FMOLS and DOLS. All explanatory variables are statistically significant. The variables of renewable energy (RENW) and carbon dioxide emissions (CO_2) are statistically significant at a 1% level, and the variables of trade openness (TRADE) and tourism arrivals are also statistically significant at 1% level.

The variables of renewable energy (RENW) and carbon dioxide emissions (CO_2) are according to H1 and H2. These results prove again that renewable energy allows and improves economic growth supporting the viability of a sustainable growth for the EU countries (Soava et al. 2018). The cointegration between renewable energy consumption and economic growth shows that clean energies are promoting sustainable development and, consequently, the growth (Álvarez-Herránz et al. 2017a Álvarez-Herranz et al. 2017b). The previous studies of Balsalobre-Lorente et al. (2018), Beer et al. (2018) and Sharifa et al. (2019) also found the same tendency. Therefore, empirical results confirm that the EU's political decisions concerning the necessity of increasing renewable energy consumption have a positive impact on economic growth, offering relevant policy implications for future decisions and evaluating programs. However, carbon dioxide emissions (CO_2) are directly correlated with economic growth, showing that CO_2 emissions are a dirty input in the promotion of economic growth the literature review shows (e.g., Shaheen et al. 2019; Ntanos et al. 2018; Alam and Paramati 2017; Papageorgiou et al. 2017). The empirical results confirm that the impact of dirty inputs in EU-28 is higher than the effect of renewable energy use on economic growth. In consequence, authorities need to impulse the promotion of

Table 7 Fixed effects estimator (FE)

Variables	FE Coef.	Expected Signs
RENW	0.151*** (0.000)	[+]
CO_2	0.271*** (0.001)	[+]
TRADE	0.625*** (0.000)	[+]
TOUR	0.591*** (0.000)	[+]
C	− 2.118*** (0.000)	
Obs	551	
Adj R^2	0.72	
Hausman test of H_0: random effects (RE) versus fixed effects (FE), asymptotic statistics chi-square (4)	− 35.890*** (0.000)	
F test	F (27,519) = 95.98*** (0.000)	

Source: Authors calculation considering the World Bank Indicators database (2019)

Dependent variable: logarithm of income per capita (LogGDP). All variables are presented in logarithm form. Statistically significant at 1% level (***)

clean energies to obtain sustainable growth. However, the variable of carbon dioxide emissions presents a positive correlation with economic growth; this result is in line with previous studies. Shaheen et al. (2019), Ntanos et al. (2018) and Alam and Paramati (2017) found a positive impact of carbon dioxide emissions on economic growth. In this context, our result shows that CO_2 emissions are a dirty input in the promotion of economic growth, as suggested by Papageorgiou et al. (2017). The direct connection between carbon emissions and economic growth suggests that in EU-28 countries still appear a high dependence of dirty energy sources, where the European Commission should reinforce their environmental and energy regulations to reduce fossil dependence and emission, in line with Kyoto and COP21 agreements. Moreover, we observe that international trade and tourism arrivals are promoting economic growth. The previous studies of Zahonogo (2017), Mustafa et al. (2017), Chen et al. (2019), Çevik et al. (2019), Mitra (2019), Tang and Tan (2017), Muhtaseb and Daoud (2017), Roudi et al. (2018) and Tang and Ozturk (2017) also found the same impact on economic growth. In consequence, our empirical results also proved that international trade encourages economic growth. This evidence confirms that trade is an essential driving force of economic growth (Kasman and Duman 2015; Al-Mulali et al. 2015; Balsalobre-Lorente et al. 2018).

Table 8 reports the results for all variables used in this study using the methodology of pairwise Dumitrescu-Hurlin panel causality tests. We observe that there is bidirectional causality between renewable energy (RENW) and economic growth (GDP), in line with Gökmenoğlu and Taspinar (2016) who obtained same results for Turkey between 1974 and 2010. The results prove that renewable energy stimulates economic growth, and support on the previous studies (Leitão 2014; Balsalobre-Lorente et al. 2018; Beer et al. 2018; Ntanos et al. 2018; Jebli et al. 2019; Sharifa et al., 2019). There is unidirectional causality between economic growth (GDP) and carbon dioxide emissions (CO_2), and economic growth (GDP) and trade openness (TRADE), and economic growth (GDP) and tourism arrivals (TOUR). We also observe that there is a unidirectional causality between tourism arrivals (TOUR) and carbon dioxide emissions (CO_2).

In a relationship with the correlation between carbon dioxide emissions (CO_2) and renewable energy (RENW), we detect a bidirectional causality between the variables; this link is in accordance with the empirical studies of Beer et al. (2018), Jebli et al. (2019) and Ntanos et al. (2018).

As in the previous studies (Mitra 2019; Jebli et al. 2019; Tavares and Leitão 2017), we can infer that there is bidirectional causality between tourism arrivals (TOUR) and trade

Table 8 Pairwise Dumitrescu-Hurlin panel causality tests

Null Hypothesis:	Causality	W-Stat.	*P* value
RENW does not homogeneously cause GDP	*GDP↔RENW*	3.791***	(0.011)
GDP does not homogeneously cause RENW		6.616***	(0.000)
CO_2 does not homogeneously cause GDP	*GDP→CO_2*	1.9105	(0.398)
GDP does not homogeneously cause CO_2		6.260***	(0.000)
TRADE does not homogeneously cause GDP	*GDP→TRADE*	1.862	(0.351)
GDP does not homogeneously cause TRADE		6.987***	(0.000)
TOUR does not homogeneously cause GDP	*GDP→TOUR*	3.027	(0.219)
GDP does not homogeneously cause TOUR		4.381***	(0.000)
CO_2 does not homogeneously cause RENW	*CO_2↔RENW*	4.662***	(0.000)
RENW does not homogeneously cause CO_2		7.047***	(0.000)
TRADE does not homogeneously cause CO_2	*CO_2↔TRADE*	4.559***	(0.000)
CO_2 does not homogeneously cause TRADE		3.417*	(0.050)
TOUR does not homogeneously cause CO_2	*TOUR→CO_2*	5.182***	(0.000)
CO_2 does not homogeneously cause TOUR		2.932	(0.293)
TOUR does not homogeneously cause RENW	*TOUR↔RENW*	4.015***	(0.003)
RENW does not homogeneously cause TOUR		4.709***	(0.000)
TRADE does not homogeneously cause RENW	*TRADE↔RENW*	3.451*	(0.057)
RENW does not homogeneously cause TRADE		5.870***	(0.000)
TOUR does not homogeneously cause TRADE	*TRADE↔TOUR*	4.565***	(0.000)
TRADE does not homogeneously cause TOUR		3.290*	(0.085)

Statistically significant at 1% (***), 5% (**) and 10% level (*). (→) unidirectional causality; (↔) bidirectional causality; (≠) non-causality

Source: Authors calculation considering the World Bank Indicators database (2019)

openness (TRADE), proving that tourism activity promotes the international trade.

Finally, according to our results, we also observe a bidirectional causality between trade openness (TRADE) and renewable energy (RENW), tourism arrivals (TOUR), and renewable energy (RENW), and trade openness (TRADE), and carbon dioxide emissions (CO_2) (Fig. 1).

In Fig. 2, we present the synthesis of the interdependence relationship between the variables under the study obtained through the method of Dumitrescu and Hurlin (2012).

Figure 2 reflects the Dumitrescu-Hurlin panel causality results, Dumitrescu-Hurlin panel causality, which is considered a second-generation causality procedure that generates robust and consistent estimates. In line with previous literature, we have obtained a bidirectional relationship between renewable energy and economic growth (Eren et al. 2019) and energy and tourism (Tiwari et al. 2013). We have found unidirectional causality running from GDP to tourism (He and Zheng 2011; Ahiawodzi 2013). The causality test also presents a unidirectional causality running from GDP to CO_2 (Lee and Brahmasrene 2013). The causality results also reflect a bidirectional relationship between tourism arrivals and trade (Yazdi et al. 2014), while we have obtained a bidirectional causality between renewable energy consumption and trade (Jebli et al. 2016).

Conclusions

Although the linkage between tourism and economic growth has been widely developed and documented in the empirical literature, this paper proposed an alternative approach, where the additional connection variables (trade, renewable energy use and carbon emissions) advance in the comprehension of economic growth's forces in EU-28. This model is shown as the main results (see Table 6) that international tourism and trade openness impact positivity on economic growth, where the energy-mix is essential to reach sustainable growth. In this sense, econometric results reveal that both clean and dirty energy sources contribute positively to enhance economic growth.

This article studied the impacts of tourism arrivals, renewable energy, trade and CO_2 emissions on economic growth using a panel data of EU-28 during 1995–2014. For testing our main hypotheses in a first step, we have run the unit root test examined by the methodology of Levin et al. (2002), ADF-Fisher Chi-square and Phillips-Perron and showed that the variables used in this empirical study are cointegrated at the first difference, I (1). Considering the Pedroni and Kao panel cointegration tests, it is possible to infer that the variables are cointegrated, establishing a long-run relationship among selected variables. The FMOLS and DOLS econometric results demonstrate that tourism arrivals promote economic growth. Thus, the impact of tourism arrivals is according to TLGH (tourism-led growth hypothesis). This result contains several implications related to tourism-related activities, where the development of the tourism industry will enhance economic growth. Besides, our study also reflects the positive effects of trade and renewable energy use on economic growth.

In this sense, the results confirm the TLGH for the case of EU-28 by suggesting that policymakers should focus on developing the development of tourism infrastructure and facilities more suitable to the post-COVID19 era. Hence, the tourism sector is an essential and dynamic factor for economic growth. Our empirical results reflect that the tourism sector supports commercial systems to achieve sustainable development objectives on the EU agenda. In short, the decision-makers need to adopt policies that protect natural and socio-cultural resources within a sustainable tourism offer.

Otherwise, our empirical results also confirm the positive impact of renewable energies on economic growth. This evidence is essential to understand the COP21 target assumed by EU-28, where policymakers need to adjust investment priorities and budget allocation to the promotion of renewable energy sources within the tourism industry and the trade

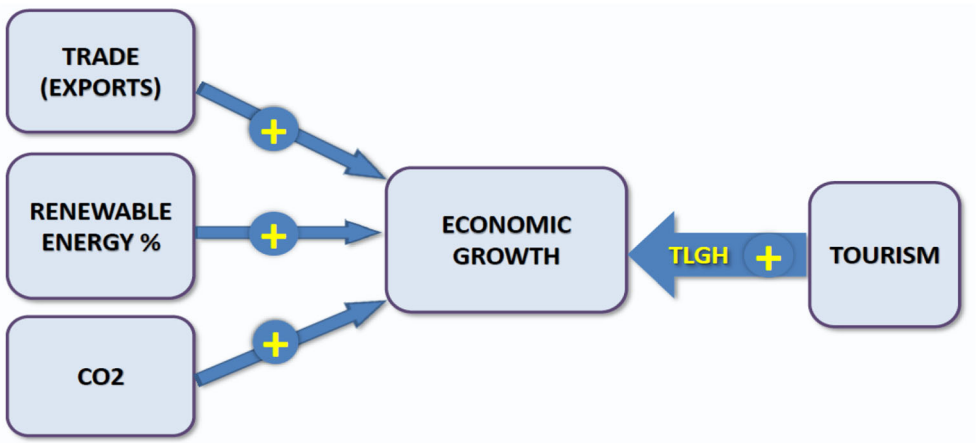

Fig. 1 Empirical abstract

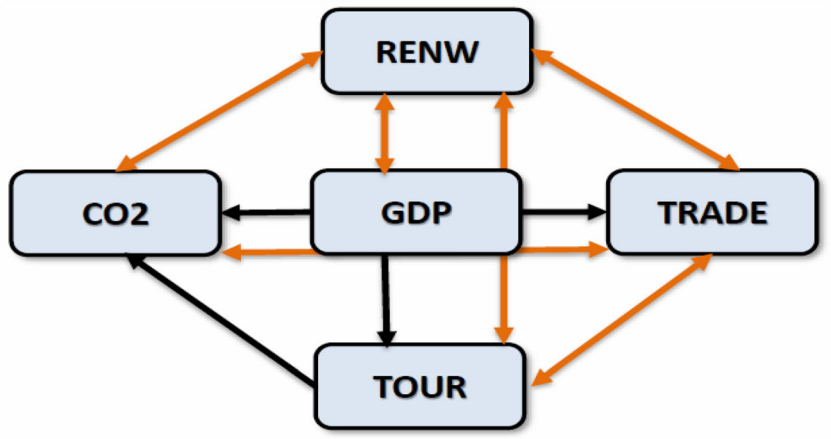

Fig. 2 Dumitrescu-Hurlin panel causality scheme

openness. In this sense, the European Commission is forced to increase clean energy sources, and the promotion of more efficient energy uses to reach environmental agreements without surrendering a sustainable economic growth. In consequence, this study presents as a novelty the assumption of a global the effects of trade openness, international tourism and energy on economic growth in EU-28.

Additionally, this study suggests that the promotion of renewable energy and boosting trade provides positive effects on economic growth in the iEU-28. Furthermore, these factors play a fundamental role in the process of sustainable economic development.

In short, there is a need for measures aimed at sustainable economic growth, based on the promotion of clean energy sources, the trade and the enhancement of the sustainable tourism industry. However, even traditionally empirical literature has shown that CO_2 emissions have a destructive effect on economic growth; our study confirms the CO_2, as a dirty input, and the use of green technologies or suitable environmental regulations generate a direct impact on economic growth. In consequence, governments need to make energy reforms, aimed to promote energy efficiency to avoid the harmful effects of a reduction of dirty inputs over economic growth. In other words, our study demonstrates that it is a necessity to adopt deep energy reforms to accelerate a transition to a cleaner energy-mix in U-28, without assuming an economic recession as a consequence of depletion of dirty energy sources.

Thus, considering the empirical results in this study, it is possible to present some recommendations. In terms of economic policy recommendations, policymakers should consider the principle of sustainable development, which sought to obtain a balance between climate change and economic growth. It will be necessary to change the paradigm, i.e., a government policy by the member states of the European Union that is based on the sustainability of natural resources and where the incentive to ecotourism will significantly reduce carbon dioxide emissions. The international community should be considering the rules of the Kyoto Protocol (1997) and, more recently, the Paris Agreement (2015).

References

Ahiawodzi AK (2013) Tourism earnings and economic growth in Ghana. BritJ Econ Finan Manag Sci 7(2):187–202

Alam MdS, Paramati SR (2017) The dynamic role of tourism investment on tourism development and CO_2 emissions. Research notes and reports. Ann Tour Res 66: 183–215

Al-Mulali U, Ozturk I, Lean HH (2015) The influence of economic growth, urbanization, trade openness, financial development, and renewable energy on pollution in Europe. Nat Hazards 79(1):621–644

Álvarez-Herránz A, Balsalobre D, Cantos JM, Shahbaz M (2017a) Energy innovations-GHG emissions nexus: fresh empirical evidence from OECD countries. Energy Policy 101:90–100

Álvarez-Herranz A, Balsalobre-Lorente D, Shahbaz M, Cantos JM (2017b) Energy innovation and renewable energy consumption in the correction of air pollution levels. Energy Policy 105:386–397

Amin SB, Kabir FA, Khan F (2019) Tourism and energy nexus in selected South Asian countries: a panel study. In: *Current Issues in Tourism*, pp 1–5

Apergis N, Payne JE (2009) CO_2 emissions, energy usage, and output in Central America. Energy Policy 378:3282–3286

Arellano M (2003) Panel data econometrics. Oxford University Press, Oxford

Azam M, Khan AQ, Abdullah HB, Qureshi ME (2016) The impact of CO_2 emissions on economic growth: evidence from selected higher CO_2 emissions economies. Environ Sci Pollut Res 23(7):6376–6389

Balaguer J, Cantavella-Jorda M (2002) Tourism as a long-run economic growth factor: the Spanish case. Appl Econ 34(7):877–884

Balsalobre-Lorente D, Gokmenoglu K, Taspinar N, Cantos-Cantos JM (2019) An approach to the pollution haven and pollution halo hypotheses in MINT countries. Environ Sci Pollut Res 26:23010–23026

Balsalobre-Lorente D, Shahbaz M, Roubaud D, Farhani S (2018) How economic growth, renewable electricity and natural resources contribute to CO_2 emissions? Energy Policy 113:356–367

Balsalobre-Lorente D, Driha OM, Sinha A (2020b) The dynamic effects of globalization process in analysing N-shaped tourism led growth hypothesis. J Hosp Tour Manag 43:42–52

Balsalobre-Lorente, D., Driha, O.M., Bekun, & Adedoyin, F.F (2020a) The asymmetric impact of air transport on economic growth in Spain: fresh evidence from the tourism-led growth hypothesis. *Current Issues in Tourism*, 1–17

Beer M, Rybár R, Kaľavský M (2018) Renewable energy sources as an attractive element of industrial tourism. Curr Issue Tour 21(18): 2139–2151

Brida JG, Cortes-Jimenez I, Pulina M (2016a) Has the tourism-led growth hypothesis been validated? A literature review. Curr Issue Tour 19(5):394–430

Brida JG, Lanzilotta B, Pizzolon F (2016b) Dynamic relationship between tourism and economic growth in MERCOSUR countries: a nonlinear approach based on asymmetric time series models. Econ Bull 36(2):879–894

Carlsson, M., Lyhagen, J., & Österholm, P. (2007). Testing for purchasing power parityco-integrated panels. International Monetary Fund (IMF), WP/07/287 Washington, DC

Castro-Nuño M, Molina-Toucedo JA, Pablo-Romero MP (2013) Tourism and GDP: a meta-analysis of panel data studies. J Travel Res 52(6):745–758

Çevik EI, Atukeren E, Korkmaz T (2019) Trade openness and economic growth in Turkey: a rolling frequency domain analysis. Economies 7(41):1–16

Chen Y, Wang Z, Zhong Z (2019) CO_2 emissions, economic growth, renewable and non-renewable energy production and foreign trade in China. *Renew Energy* 131:208–216

Chirwa TG, Odhiambo NM (2018) Exogenous and endogenous growth models: a critical review. Compar Econ Res 21(4):63–84

Choi I (2001) Unit Root Tests for Panel Data. J Int Money Finance 20(2): 249–272

Den Butter FAG, Verbruggen H (1994) Measuring the trade-off between economic growth and a clean environment. Environ Resour Econ 4(2):187–208

Dogan E, Seker F (2016) The influence of real output, renewable and non-renewable energy, trade and financial development on carbon emissions in the top renewable energy countries. Renew Sust Energ Rev 60:1074–1085

Dogan E, Seker F, Bulbul S (2017) Investigating the impacts of energy consumption, real GDP, tourism and trade on CO2 emissions by accounting for cross-sectional dependence: A panel study of OECD countries. Curr Issues Tour 20(16):1701–1719

Dollar D (1992) Outward-oriented developing economies really do grow more rapidly: evidence from 95 LDCs, 1976-1985. Econ Dev Cult Chang 40:523–524

Dollar D, Kraay A (2004) Trade Growth and Poverty. *Econ J* 114:22–49

Domar ED (1946) Capital expansion, rate of growth, and employment. Econometrica 14:137–147

Dumitrescu EI, Hurlin C (2012) Testing for Granger non-causality in heterogeneous panels. Econ Model 29(4):1450–1460

Edmond CV, Midrigan DY, Xu (2015) Competition, mark-ups, and the gains from international trade. Am Econ Rev 105(10):3183–3221

Eren BM, Taspinar N, Gokmenoglu KK (2019) The impact of financial development and economic growth on renewable energy consumption: empirical analysis of India. Sci Total Environ 663:189–197

European Parliament (2016) Promotion of renewable energy sources in the EU. EU policies and Member State approaches, European Union, 24 p Retrieved from http://www.europarl.europa.eu/RegData/etudes/IDAN/2016/583810/EPRS_IDA(2016)583810_EN.pdf

Ferrer-Roca, N., Weston, R., Guia, J., Mihalic, T., Blasco, D., Prats, L., & Jarratt, D. (2020). Back to the future: challenges of European tourism of tomorrow. ***Journal of Tourism Futures.in press***

Frankel JA, Romer D (1999) Does trade cause growth? Am Econ Rev 89: 379–399

Frankel, J.A., & Romer, D. (1996). Trade and growth: an empirical investigation. NBER Working Paper. 5476

Freund C, Bolaky B (2008) Trade, regulations, and income. J Dev Econ 87:309–321

Gökmenoğlu K, Taspinar N (2016) The relationship between CO_2 emissions, energy consumption, economic growth and FDI: the case of Turkey. J Int Trade Econ Dev 25(5):706–723

Grossman G, Helpman E (1991) Quality ladders in the theory of growth. Rev Econ Stud 58:43–61

Hamit-Haggar M (2012) Greenhouse gas emissions, energy consumption and economic growth: a panel cointegration analysis from Canadian industrial sector perspective. Energy Econ 34(1):358–364

He LH, Zheng XG (2011) Empirical analysis on the relationship between tourism development and economic growth in Sichuan. J Agric Sci 3(1):212–217

Hwang JH, Yoo SH (2014) Energy consumption, CO_2 emissions, and economic growth: evidence from Indonesia. Qual Quant 48(1):63–73

Im KS, Pesaran MH, Shin Y (2003) Testing for unit roots in heterogeneous panels. J Econ 115(1):53–74

Isik C, Dogru T, Turk ES (2018) A nexus of linear and non-linear relationships between tourism demand, renewable energy consumption, and economic growth: theory and evidence. Int J Tour Res 20(1): 38–49

Jambor A, Leitão NC (2017) Economic growth and sustainable development: evidence from central and Eastern Europe. Int J Energy Econ Policy 7(5):171–177

Jebli MB, Youssef SB, Ozturk I (2016) Testing environmental Kuznets curve hypothesis: the role of renewable and non-renewable energy consumption and trade in OECD countries. Ecol Indic 60:824–831

Jebli MB, Youssef SB, Apergis N (2019) The dynamic linkage between renewable energy, tourism, CO_2 emissions, economic growth, foreign direct investment, and trade. Latin Am Econ Rev 28(2):1–19

Jebli MB, Youssef SB, Apergis N (2015) The dynamic interaction between combustible renewables and waste consumption and international tourism: the case of Tunisia. Environ Sci Pollut Res 22: 12050–12061

Kahia M, Kadria M, Aissa MSB, Lanouar C (2017) Modelling the treatment effect of renewable energy policies on economic growth: Evaluation from MENA countries. J Clean Prod 149:845–855

Kao C (1999) Spurious regression and residual-based tests for cointegration in panel data. J Econ 90(1):1–44

Kao C, Chiang M-H (1998) On the estimation and inference of a cointegrated regression in panel data, Working Paper, Center for Policy Research. Syracuse University

Kasman A, Duman YS (2015) CO_2 emissions, economic growth, energy consumption, trade and urbanization in new EU member and candidate countries: a panel data analysis. Econ Model 44:97–103

Keho Y (2017) The impact of trade openness on economic growth: the case of cote d'Ivoire. Cogent Econ Finan 5(1):1332820

Kyoto Protocol (1997) United Nations framework convention on climate change. Kyoto Protocol, Kyoto 19:497

Lee JW, Brahmasrene T (2013) Investigating the influence of tourism on economic growth and carbon emissions: evidence from panel analysis of the European Union. Tour Manag 38:69–76

Leitão NC (2014) Economic growth, carbon dioxide emissions, renewable energy, and globalization. Int J Energy Econ Policy 4(3):391–399

Levin A, Lin CF, Chu CSJ (2002) Unit root test in panel data: asymptotic and finite sample properties. J Econ 108:1–24

Long NV, Miao Z (2019) Vertically differentiated Cournot oligopoly: effects of market expansion and trade liberalization on relative mark-up and product quality, Tokyo

Lucas R (1988) On the mechanics of economic development. J Monet Econ 22:3–42

Mitra SK (2019) Is tourism-led growth hypothesis still valid? Int J Tour Res 21(5):615–624

Muhtaseb BM, Daoud HE (2017) Tourism and economic growth in Jordan: evidence from linear and nonlinear frameworks. Int J Econ Financ Issues 7(1):214–223

Mustafa G, Rizov M, Kernohan D (2017) Growth, human development, and trade: the Asian experience. Econ Model 61:93–101

Narayan PK, Narayan S (2005) Estimating income and price elasticities of imports for Fiji in a cointegration framework. Econ Model 22(3): 423–438

Ntanos S, Skordoulis M, Kyriakopoulos G, IArabatzis G, Chalikias M, Galatsidas S, Batzios A, Katsarou A (2018) Renewable energy and economic growth: evidence from European countries. Sustainability 10(2626):1–13

Ozatac N, Gokmenoglu KK, Taspinar N (2017) Testing the EKC hypothesis by considering trade openness, urbanization, and financial development: the case of Turkey. Environ Sci Pollut Res 24(20): 16690–16701

Ozcan B, Ozturk I (2019) Renewable energy consumption-economic growth nexus in emerging countries: a bootstrap panel causality test. Renew Sust Energ Rev 104:30–37

Papageorgiou C, Saam M, Schulte P (2017) Substitution between clean and dirty energy inputs: a macroeconomic perspective. Rev Econ Stat 99(2):281–290

Paramati SR, Alam MS, Lau CKM (2018) The effect of tourism investment on tourism development and CO_2 emissions: empirical evidence from the EU nations. J Sustain Tour 26(9):1587–1607

Pedroni P (1999) Critical values for cointegration tests in heterogeneous panels with multiple regressors. Oxf Bull Econ Stat 61:653–670

Rebelo S (1991) Long-run policy analysis and long-run growth. J Polit Econ 99(3):500–521

Romer P (1986) Increasing returns and long run growth. J Polit Econ 98(5):71–102

Roudi S, Arasli H, Akadiri SS (2018) New insights into an old issue—examining the influence of tourism on economic growth: evidence from selected small island developing states. Curr Issue Tour 22(11):1280–1300

Saikkonen P (1991) Asymptotically efficient estimation of cointegration regressions. Econometric Theory 7(1):1–21

Sebri M, Ben-Salha O (2014) On the causal dynamics between economic growth, renewable energy consumption, CO_2 emissions and trade openness: fresh evidence from BRICS countries. Renew Sust Energ Rev 39:14–23

Shaheen K., Zaman, K., Batoo, R., Khurshid, M., A., Aamir, A. Shoukry, A.M., Sharkawy, A. M., Aldeek, F., Khader, J., & Gani, S. (2019). Dynamic linkages between tourism, energy, environment, and economic growth: evidence from top 10 tourism-induced countries. Environ Sci Pollut Res, 26, 31273–31283

Sharif A, Saha S, Campbell N, Sinha A, Ibrahiem DM (2019) Tourism, environment, and energy: an analysis for China. Curr Issue Tour:1–20

Soava G, Mehedintu A, Sterpu M, Raduteanu M (2018) Impact of renewable energy consumption on economic growth: evidence from European Union countries. Technol Econ Dev Econ 24(3):914–932

Solow RM (1956) A contribution to the theory of economic growth. Q J Econ 70(1):65–94

Stock JH, Watson MW (1993) Simple estimator of cointegrating vectors in higher order integrated systems. Econometrica 61(4):783–820

Tang CF, Ozturk I (2017) Is tourism a catalyst of growth in Egypt? Evidence from Granger non-causality and the generalised variance decomposition analysis. Anatolia 28(2):173–181

Tang CF, Tan EC (2017) Tourism-led growth hypothesis: a new global evidence. Cornell Hosp Q 59(3):304–311

Tang CF, Tiwari AK, Shahbaz M (2016) Dynamic inter-relationships among tourism, economic growth, and energy consumption in India. Geosystem engineering 19(4):158–169

Tavares JM, Leitão NC (2017) The determinants of international tourism demand for Brazil. Tour Econ 23(4):834–845

Thorpe M, Leitão NC (2014) Economic growth in Australia: globalisation, trade and foreign direct investment. Global Bus Econ Rev 16(1):75–86

Tiwari AK, Ozturk I, Aruna M (2013) Tourism, energy consumption and climate change in OECD countries. Int J Energy Econ Policy 3:247–261

Ulucak R, Khan SUD, Baloch MA, Li N (2020) Mitigation pathways toward sustainable development: is there any trade-off between environmental regulation and carbon emissions reduction? Sustain Dev in (press)

UNFCCC (2015). United nations framework convention on climate change. Paris agreement, New York

White H (1982) Instrumental variables regression with independent observations. Econometrica 50(2):483–499

White H (1984) Asymptotic theory for econometricians. Academic Press, Orlando, FL

World Tourism Organization (2018) European Union tourism trends. UNWTO, Madrid. https://doi.org/10.18111/9789284419470

World Bank (2019) World development indicators database. https://databank.worldbank.org/source/world-development-indicators

Yazdi SK, Shakouri B, Khanalizadeh B (2014) The granger causality among tourist arrival, economic growth, and CO_2 emissions in Iran. Adv Environ Biol 8(13):632–637

Yorucu V, Kirikkaleli D (2017) Empirical modeling of education expenditures for Balkans: evidence from panel FMOLS and DOLS estimations. Revista de Cercetare si Interventie Sociala 56:88–101

Zafar MW, Shahbaz M, Hou F, Sinha A (2019) From nonrenewable to renewable energy and its impact on economic growth: the role of research & development expenditures in Asia-Pacific Economic Cooperation countries. J Clean Prod 212:1166–1178

Zahonogo P (2017) Trade and economic growth in developing countries: evidence from sub-Saharan Africa. Journal of African Trade 3:41–56