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Tourism, economic growth, and tourism-induced EKC hypothesis: evidence from the Mediterranean region

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Abstract

This paper investigates the relationship among CO_2 emissions, energy consumption, economic growth and tourism development using data for a panel of 18 Mediterranean countries over the period 1995–2010. The findings from cointegrating polynomial regression indicate that the tourism-induced environmental Kuznets curve (EKC) hypothesis is confirmed for three out of nine countries for which cointegration tests suggest a long-run equilibrium relationship between the examined variables. A group of causalities have been found for the Mediterranean countries. In particular, our results demonstrate bidirectional causality between GDP and tourism development for the Northern Mediterranean countries, while for the southern and global panel we document one-way causality running from tourism development to economic growth. We also show unidirectional causality running from tourism to CO_2 emissions across regions. The empirical results suggest that Mediterranean countries should place more emphasis on tourism development, sustainable tourism in particular, given the potential relationship among tourism development, GDP and CO_2 emissions.

Keywords Tourism-induced EKC hypothesis · Cointegrating polynomial regressions · Panel causality · Economic growth · Mediterranean countries

JEL Classification O40 · L83

1 Introduction

With rapid population growth, changes in lifestyles, and increasing level of energy consumption, tourism's role as a significant contributor to climate change has gradually gained academic attentions. Although the relationship between

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economic growth, energy consumption and CO_2 emissions has been extensively explored in the literature, relatively little attention has been paid to this interaction regarding a specific sector, such as the tourism sector which has emerged as one of the leading service sectors in the world recently. Given the potential strong link among tourism activities, energy consumption and emissions, an emerging strand of studies has begun to investigate the environment-tourism-growth nexus (Katircioglu 2014; Zhang and Gao 2016; Dogan and Aslan 2017). Globally, tourism is considered a main stimulus in economic development in many countries, contributing roughly 10% of total GDP. It is estimated that one out of 11 jobs is related to the tourism sector around the world (UNWTO 2013). In the meantime, tourism development leads to growth in energy consumption as well as potential environmental degradation which may in turn affect tourism growth. It is acknowledged that tourism sectors need to enact and implement appropriate policies to deal with the changing climate conditions, as well as to reduce tourism's impact on the environment. Against this backdrop, it is significant to learn more about the interaction between CO_2 emissions, energy consumption, and economic growth under the tourism context.

The importance of the tourism industry to the Mediterranean region can be understood based on the statistics released by World Travel & Tourism Council (2015). According to WTTC (2015), the tourism sector in the Mediterranean countries contributed to 1019 billion US dollars in 2014, accounting for 11.3% of total GDP. Moreover, it created job opportunities by providing roughly 19.63 million jobs, including 7.8 million direct jobs and 8 million indirect jobs (WTTC 2015). Historically, Mediterranean tourism has been dominated by the Northern Mediterranean European countries. Tourism accounts for more than 10% of total GDP in major industrialized countries in the northern rim of the Mediterranean, such as France and Italy, both of which are the top five world tourist destinations. In other countries such as Greece and Malta, tourism is one of the most important parts of their economies. According to WTTC (2015), tourism contributes to approximately 17% and 28% of the total GDP in Greece and Malta, respectively. In the past two decades, Southern Mediterranean countries have witnessed a high growth in their tourism sectors, which is often regarded as a source of revenue and employment. On average, the tourism sector contributed to roughly 10% of the total GDP in the Southern Mediterranean countries, ranging from 5.5% in Libya to 21.1% in Lebanon in 2014 (WTTC 2015). In terms of international tourist arrivals, Morocco experienced a 200% increase over the past decade, placing it the top one tourist destination in Africa.

With the rapid development of the tourism sectors in the Mediterranean, concerns arise regarding the negative impact of tourism growth on the environment. The tourism sector is a major contributor to climate change, and simultaneously it is also a victim to climate change as well. The impact of climate change is a global issue, and its consequences on the Mediterranean are potentially significant. For the Mediterranean, which has been famous for its "sun & beach" offerings, tourism is intrinsically related to the consumption of large amounts of energy, fossil fuel in particular. It is estimated that CO_2 emissions emitted from energy consumption in the tourism sectors around the world account for some 5%

of global total emissions (UNWTO 2008). Besides large amounts of CO_2 emissions, continued tourism growth may cause other disasters such as loss of biodiversity, water pollution and so on. Hence, there is an urgent need for the tourism sector in the Mediterranean to design and enact policies to cope with climate change and to take steps to mitigate tourism's negative environmental impacts.

Given discussions above, it is acknowledged that climate change, energy consumption and economic growth are mutually dependent within the tourism context and must be dealt in a holistic manner. A better understanding of the relationship between economic growth, energy consumption and CO_2 emissions under the tourism context is necessary from a sustainable development perspective, in particular for policy makers to enact sustainable tourism development policies in the Mediterranean region.

The primary purpose of the present study is to investigate the relationship among tourism development, economic growth and CO_2 emissions in the Mediterranean region. The present study extends the literature on the relationship among economic growth, energy consumption and CO_2 emissions in three ways. First, to the best of our knowledge, this is among the first studies which investigate the relationship between economic growth, energy consumption and CO_2 emissions under the tourism context for the case of the Mediterranean countries. Unlike previous studies such as Lee and Brahmasrene (2013), we focus on the Mediterranean countries instead of the entire European continent by dividing the Mediterranean region into Southern and Northern. Given that the Northern Mediterranean is not directly comparable to Southern Mediterranean countries because the latter's special economic and institutional nature make it more likely to be affected by climate change. In addition, the Northern Mediterranean is usually considered among the most competitive tourism destinations in the world, while Southern Mediterranean countries are not as competitive as their northern counterparts. Southern Mediterranean countries, such as Libya and Egypt, have also faced more security risks and economic uncertainty since the wake of Arab Spring than the Northern Mediterranean. Disaggregating the sample can provide additional insights to policy makers given the potential heterogeneity of economic structures and institutional characteristics existing in the region. It is expected that the empirical findings will result in disparate policy implications for different regions. Second, we investigate the existence of tourism-induced EKC hypothesis in the Mediterranean using the most recent econometric methodology–cointegrating polynomial regression which was proposed by Wagner and Hong (2016). The tourism-induced EKC hypothesis has been examined in a few studies (Katircioglu 2014b; de Vita et al. 2015). However, the existing EKC literature suffers from a potential methodological concern owning to the inclusion of powers of integrated variables in the FMOLS estimation (Wagner 2008, 2015). To address this concern, Wagner (2015) and Wagner and Hong (2016) modified the FMOLS and extended it to the cointegrating polynomial regressions (CPR). We contribute to the literature by providing both regional evidence and country-specific evidence in the Mediterranean area (developed verse developing). Finally, in the literature most researchers explored only the relationship between tourism and economic growth or between tourism and emissions. However, it is vital to investigate the dynamic relationship among tourism development, economics growth and CO_2 emissions in a combined approach and this is what we do in the present study.

The rest of the paper is organized as follows. Section 2 presents a brief review of the relevant literature. Section 3 discusses the main model and data source. Section 4 discusses the econometric methodology. Section 5 presents the empirical results and discussions. The final section concludes the study.

2 Literature review

Given the growing importance of the tourism sector, a plethora of studies have investigated the tourism-led growth hypothesis. Recently an emerging strand of the literature began to explore the existence of tourism-induced EKC hypothesis. Another line of the literature, which is the marriage of the first two strands, explores the relationship between economic growth, energy consumption and CO_2 emissions under the tourism context. The literature review section summarizes and covers relevant studies in these areas.

2.1 Tourism and economic growth

Since the seminal works of Hazari and Sgro (1995) and Lanza and Pigliaru (2000), the relationship between tourism and economic growth has been extensively investigated with mixed results. The direction of causality is vital as policy implication derived from empirical findings can be entirely different. Generally, four types of relationships regarding tourism expansion and economic growth have been proposed in the extant literature.

First, unidirectional causality running from tourism to economic growth is referred to as tourism-led growth (TLG) hypothesis (see, for example, Balaguer and Cantavella-Jorda 2002; Dritsakis 2004; Lee and Chang 2008; Tang and Abosedra 2014; Katircioglu et al. 2018a). It implies that the development of tourism plays an important role in determining economic growth. Second, unidirectional causality running from economic growth to tourism is known as economic driven tourism growth (EDTG) hypothesis (e.g., Narayan 2004; Oh 2005; Katircioglu 2009). It implies that a less developed tourism sector may have little negative impact on the overall economy. This hypothesis is bolstered if economic growth is a deciding factor to the increase in tourism development. Third is the bidirectional causality between tourism and economic growth (e.g., Durbarry 2004; Kim et al. 2006). It suggests tourism and the broader economy interplay and are jointly and simultaneously affected. Finally, there is also evidence that there is no causality between tourism and economic growth (e.g., Katircioglu 2009; Brida et al. 2011; Tugcu 2014). It implies that tourism is uncorrelated with GDP. Thus, any policies which aim to affect the tourism sector may not affect the overall economy.

As the focus of this study is the Mediterranean region, it is interesting to review the relevant literature which addresses the TLG in the region. A literature search indicates that most investigated countries lie in the northern rim of the Mediterranean, while there is a lack of studies for countries in the southern rim of the Mediterranean (Dritsakis 2004; Gunduz and Hatemi 2005; Cortés-Jiménez 2008;

Massidda and Mattana 2013). The literature search also indicates that the relationship between tourism and economic development is largely inconclusive. For example, Cortés-Jiménez (2008) found a unidirectional causality from tourism to economic development in Italy, while Massidda and Mattana (2013) verified the bidirectional causality between tourism and economic growth in the same country. For Greece, Dritsakis (2004) suggested that there is a long-run two-way causality between tourism expansion and economic development. In contrast, Eeckels et al. (2012) found a one-way causality running from tourism to economic growth over the period 1976–2004 using spectral analysis. Likewise, Gunduz and Hatemi (2005) validated the TLG hypothesis for Turkey while the result from Katircioglu (2009) indicated no evidence of causality.

A survey of the literature indicates that the relationship between tourism and economic growth is still inconclusive due to differences in the sampled countries (countries traditionally reliant on tourism or island countries), data sources (time series, cross-sectional and panel data), time spans (large versus small dimensions), proxy variables for tourism (receipts versus arrivals) and econometric models (dynamic versus non-dynamic). Understanding the causal relationship is important to policy makers in designing and implementing tourism development policies; thus, the causality between tourism and economic growth is still a matter yet open to question (Chatziantoniou et al. 2013).

2.2 Tourism-induced EKC hypothesis

The second strand of the literature concentrates on the existence of tourism-induced EKC hypothesis. The existence of the environmental Kuznets curve (EKC) hypothesis has been extensively explored in the literature since the pioneering work of Grossman and Krueger (1995). However, the results regarding the existence of the EKC hypothesis are largely mixed. Attempts have been made to extend the conventional EKC framework by including additional variables which may contribute to confirm the validity of the EKC hypothesis, such as income distribution (Torras and Boyce 1998; Bimonte 2002), trade (Suri and Chapman 1998), technology changes (Lantz and Feng 2006), oil prices (Moomaw and Unruh 1997) and energy consumption (Halicioglu 2009; Jalil and Mahmud 2009). In spite of these extensions, little emphasis has been placed on the role of the tourism sector.

Recently, a number of studies have investigated the impact of tourism on CO_2 emissions (Katircioglu 2014a; Katircioglu et al. 2014; Lee and Brahmasrene 2013). Katircioglu (2014a) investigated the effect of tourism on CO_2 emissions in Turkey and found that tourism positively affects CO_2 emissions in Turkey. The findings show that a one percent increase in the tourism variable increases CO_2 emissions by 0.106 percent. Katircioglu et al. (2014) arrived at similar conclusions when they explored this issue in Cyprus. They found that a one percent increase in the tourism variable increases CO_2 emissions by 0.033 percent. In contrast, Lee and Brahmasrene (2013) found that tourism development negatively affects CO_2 emissions. According to their findings, a one percent increase in tourism receipts decreases CO_2 emissions by 0.105 percent in the European Union. Furthermore, an emerging strand of the literature has further investigated the so-called tourism-induced EKC hypothesis (Katircioglu 2014b; de Vita et al. 2015; Katircioglu et al. 2018b). Katircioglu (2014b) explored the tourism-induced EKC hypothesis in the case of Singapore and confirmed its existence. Using a long time series data covering the period 1960–2009 for Turkey, de Vita et al. (2015) lent empirical support to the existence of the tourism-induced EKC hypothesis. Katircioglu et al. (2018b) confirmed the existence of tourism-induced EKC in top ten tourist countries.

2.3 A combined approach

The last strand of the literature, resulting from the marriage of the first two strands of the literature, investigates the relationship between economic growth, tourism, energy consumption and CO_2 emissions in a combined approach (Lee and Brahmasrene 2013; Katircioglu 2014b; de Vita et al. 2015; Zaman et al. 2016). Unlike the first two strands of the literature, this new line of the literature investigates the causal relationship between economic growth, energy consumption and CO_2 emissions under the tourism context. Doing so not only provides evidence for the TLG and tourism-induced EKC hypotheses but also offers additional insights regarding the complex relationship between these key variables. The literature search also suggests that like the TLG hypothesis, there is much additional room to extend the current literature by investigating the tourism-induced EKC hypothesis, as well as by exploring the causal relationship between the variables in a tourism context in other countries or regions where tourism plays an important role.

3 Data source and the model

This study uses annual data for a panel of 18 Mediterranean countries,[1] namely Albania, Croatia, Cyprus, France, Greece, Italy, Malta, Slovenia, Spain, Turkey, Algeria, Egypt, Israel, Lebanon, Libya, Morocco, Syria, and Tunisia on their CO_2 emissions, energy consumption, GDP and tourism receipts over the period of 1995–2010.[2] It is important to note that we used the longest data available given that the tourism data are not available until 1995 while the CO_2 emissions is not available after 2011. As mentioned above, the Mediterranean[3] is divided into North and South according to geographical positions. Annual per capita data on CO_2 emissions (kt per capita), energy consumption (kg of oil equivalent per capita), GDP (current US$ per capita) and tourism receipts (current US$ per capita) were obtained from

[1] Totally there are 21 countries in the Mediterranean region. Given data constraints, 18 countries were chosen for analysis.

[2] Given the sample size used in this study is relatively small, therefore the results should be interpreted with caution.

[3] The Northern Mediterranean includes Albania, Croatia, Cyprus, France, Greece, Italy, Malta, Slovenia, Spain, Turkey and the Southern Mediterranean includes Algeria, Egypt, Israel, Lebanon, Libya, Morocco, Syria and Tunisia.

World Development Indicators. All variables are converted into natural logarithms before analysis.

To explore the causal relationship between energy consumption, economic growth, tourism development and carbon dioxide emissions and confirm the tourism-induced environmental Kuznets curve (EKC) hypothesis under the context of Mediterranean countries, following the approach proposed by Katircioglu (2014), we specify the long-run relationship between the above-mentioned variables as follows:

$$CO_{2it} = \beta_0 + \beta_1 GDP_{it} + \beta_2 GDP_{it}^2 + \beta_3 ENE_{it} + \beta_4 TOUR_{it} + \varepsilon_{it} \tag{1}$$

where the subscripts i and t represent country and time, respectively. CO_2 stands for carbon dioxide emissions. GDP and GDP^2 represent real GDP and the squared term of GDP. ENE represents energy consumption, and TOUR is the tourism receipts. All data are taken natural logarithm before analysis, since log-linear models can provide more efficient and appropriate results than linear models (Cameron 1994). Thus, the coefficients of β_1, β_2, β_3 and β_4 are the long-run elasticities of CO_2 emissions with respect to GDP, GDP squared, energy consumption and tourism receipts, respectively. Theoretically, the EKC hypothesis reveals that $\beta_1 > 0$ and the sign of squared GDP should be negative which implies $\beta_2 < 0$. It is expected that the sign of β_3 is positive since increased energy consumption leads to an increase in emissions. The expected sign of β_4 is inconclusive given mixed results in the literature (e.g., Lee and Brahmasrene 2013; Katircioglu 2014a, b). ε_{it} is the error term.

4 Econometric methodology

4.1 CD and panel unit root tests

Consistent with the existing literature, the econometric analysis begins with panel unit root tests to check the order of integration and the stationary property of the series to avoid spurious regressions. We first implement Pesaran (2004) cross-sectional dependence test (CD test) to explore whether the panel time series data is cross-sectionally dependent. The lower test power would invalidate the first generation panel unit root test if the series has a cross-sectional dependence. In the presence of the cross-sectional dependence, the CADF and CIPS panel unit root tests proposed by Pesaran (2007) are superior to the conventional panel unit root tests and thus should be employed since the first generation panel unit root tests overlook the potential cross-sectional dependence in the series.

4.2 Panel cointegration tests

After examining the stationary property of the series, we proceed to do the panel cointegration tests. Given the presence of the cross-sectional dependence in the data set, Westerlund (2007) test is preferred. However, given the short time length of our data, we cannot apply this test and instead use the Pedroni (2004) test. For robustness, we also implement the Kao's (1999) test, which is based on Engle-Granger two-step (residual based) cointegration tests. Pedroni's (2004) residual panel cointegration tests are based on the following equation:

$$Y_{it} = \beta_i + \rho_i t + \sum_{j=1}^{m} \alpha_{ji} X_{jit} + \varepsilon_{it} \tag{2}$$

where $i = 1, \ldots, I$ denotes the country, $j = 1,\ldots,m$ represents the number of regressors, and $t = 1, \ldots, T$ refers to the time period and β_i and ρ_i are the intercept and deterministic trend specific to each country, respectively.

To test the existence of cointegration, the test based on the residual term ε_{it} is conducted as follows:

$$\varepsilon_{it} = \delta_i \varepsilon_{it-1} + u_{it} \tag{3}$$

The null hypothesis states that $\delta_i = 1$ and the alternative hypothesis is that $\delta_i < 1$. Pedroni (1999, 2004) advanced two sets of tests: panel cointegration tests and group mean panel cointegration tests. Panel cointegration tests are based on the within dimension technique, which contains four statistics (panel v-statistic, panel ρ-statistic, panel PP-statistic, and panel ADF-statistic). The group tests containing three statistics (group ρ-statistic, group PP-statistic, and group ADF-statistic) are based on the between dimension approach. In similar spirit, the Kao's (1999) test can be constructed to specify cross-sectional specific intercepts and homogeneous coefficients at the first stage.

4.3 FMOLS estimation and cointegrating polynomial regression

Once the cointegration relationship is confirmed, fully modified OLS (FMOLS) proposed by Pedroni (2001) was estimated. Based on Pedroni (2001), the panel FMOLS estimator is given as:

$$\hat{\beta} = N^{-1} \sum_{i=1}^{N} \left(\sum_{t=1}^{T} \left(x_{it} - \bar{x}_i\right)^2 \right)^{-1} \left(\sum_{t=1}^{T} \left(x_{it} - \bar{x}_i\right) z_{it}^{*} - T \cdot \hat{\gamma}_i \right) \tag{4}$$

where $z_{it}^{*} = \left(z_{it} - \bar{z}_i\right) - \frac{\hat{\Omega}_{21i}}{\hat{\Omega}_{22i}} \Delta x_{it}, \hat{\gamma}_i \equiv \hat{\Gamma}_{21i} + \hat{\Omega}_{21i}^{0} - \frac{\hat{\Omega}_{21i}}{\hat{\Omega}_{22i}} \left(\hat{\Gamma}_{22i} + \hat{\Omega}_{22i}^{0} \right)$. $\Omega_i \equiv \lim_{T\to\infty} E\left[T^{-1}\left(\sum_{t=1}^{T} \xi_{it}\right)\left(\sum_{t=1}^{T} \xi_{it}'\right)\right]$ is the long-run covariance which can be decomposed as $\Omega_i = \Omega_i^0 + \Gamma_i + \Gamma_i'$, where Ω_i^0 is the contemporaneous covariance and Γ_i is a weighted sum of autocovariances. Compared with OLS, FMOLS is superior since it allows for heterogeneity and solves the problem of serial correlation and simultaneity bias.

Motivated by the environmental Kuznets curve hypothesis, Wagner and Hong (2016) extend the FMOLS estimator to cointegrating polynomial regressions (CPR). CPR includes deterministic variables, integrated process, and integer powers of integrated process as independent variables. As argued by Wagner (2008), a large plethora of the EKC literature suffers from the methodological concern as it overlooks the fact that powers of integrated process are not necessarily themselves integrated process. Therefore, prior FMOLS techniques should be properly extended. Recently, the novel econometric methodology has been used to investigate the existence of EKC in 19 industrialized countries (Wagner 2015). Thus, our analysis is based on the fully modified OLS (FMOLS) estimator developed by Wagner and Hong (2016).

4.4 Panel Granger causality tests

The existence of cointegrated relationship suggests that there is a long-run relationship between CO_2 emissions, energy consumption, tourism development and economic growth, we proceed to examine the causal relationship among these variables. In this study, we choose the Dumitrescu and Hurlin (2012) panel causality test since it has good small sample properties, even in the presence of cross-sectional dependence. Dumitrescu and Hurlin (2012) test consider the following model:

$$Y_{it} = \alpha_i + \sum_{k=1}^{K} \gamma_i^{(k)} Y_{i,t-k} + \sum_{k=1}^{K} \beta_i^{(k)} X_{i,t-k} + \varepsilon_{it} \tag{5}$$

where K$\in N^*$ and $\beta_i=\left(\beta_i^{(1)}, \ldots, \beta_i^{(k)}\right)$. The null hypothesis is defined as H_0: $\beta_i = 0, \forall$ $i=1$, 2,……N and the alternative hypothesis is defined as H_1:$\beta_i = 0, \forall \quad i = 1, 2, \ldots, N_1$ and $\beta_i \neq 0, \forall i = N_1 + 1, N_1 + 2, \ldots, N$. Specifically, the null hypothesis states that there is no homogeneous Granger causality in the panel, while the alternative hypothesis states that at least one causality can be found in the panel.

5 Empirical results and discussions

The summary statistics (mean and standard deviation) of the variables are listed in Table 1. The mean of CO_2 emissions ranges from 1.122 in Albania to 9.141 in Israel. Regarding GDP, it is noted that France has the largest per capita amount, followed by Italy and Spain. As for energy consumption, it appears that Morocco has the smallest use while France has the largest, followed by Slovenia and Italy. Finally, when it comes to tourism receipts, Cyprus has the highest per capita amount, while Algeria has the lowest in the sampled Mediterranean countries. In terms of total amount, untabulated statistics show that France has the highest amount while Libya has the lowest.

5.1 CD and panel unit root results

Table 2 reports the results of the Pesaran (2004) cross-sectional dependence tests. The results reveal that the null hypothesis of no cross-sectional dependence is rejected at 5% statistical significance level for all analyzed variables across all panels, suggesting a strong cross-sectional dependence. That is, CO_2 emissions, energy

Table 1 Summary statistics of time series variables

Country	CO_2	ENE	GDP	TOUR
Albania				
Mean	1.122	608.266	2137.423	255.251
Stdev	0.367	124.023	1327.101	233.639
Croatia				
Mean	4.651	2033.981	8634.200	1260.420
Stdev	0.505	173.497	3945.382	740.307
Cyprus				
Mean	7.190	2202.730	21725.370	2369.256
Stdev	0.436	100.861	7610.161	265.755
France				
Mean	5.944	4144.357	31261.450	726.830
Stdev	0.261	112.567	7846.456	184.835
Greece				
Mean	8.352	2536.461	19424.000	970.338
Stdev	0.520	201.732	7156.206	400.006
Italy				
Mean	7.729	3008.554	27958.180	606.166
Stdev	0.422	142.704	7276.120	101.346
Malta				
Mean	6.126	1972.432	14206.44	2228.925
Stdev	0.422	130.679	4542.419	295.055
Slovenia				
Mean	7.748	3433.766	16032.470	840.063
Stdev	0.342	213.046	6091.308	336.814
Spain				
Mean	7.030	2938.495	22312.550	993.330
Stdev	0.795	255.357	7706.279	234.416
Turkey				
Mean	3.471	1233.901	5952.784	212.326
Stdev	0.391	131.072	2885.711	108.044
Algeria				
Mean	3.071	940.856	2594.811	5.999
Stdev	0.267	115.133	1181.994	4.627
Egypt				
Mean	2.006	708.537	1438.586	86.297
Stdev	0.330	127.846	472.733	39.402
Israel				
Mean	9.141	2881.003	21838.300	577.385
Stdev	0.434	111.822	4058.441	139.401
Lebanon				
Mean	4.540	1452.621	5796.647	988.503
Stdev	0.562	185.964	1309.906	676.313

Table 1 (continued)

Country	CO_2	ENE	GDP	TOUR
Libya				
Mean	8.946	3011.622	7625.393	21.983
Stdev	0.412	142.890	3042.290	17.440
Morocco				
Mean	1.365	430.192	1895.381	146.366
Stdev	0.220	64.864	584.1397	82.849
Syria				
Mean	2.970	998.501	1503.488	107.662
Stdev	0.274	98.714	621.871	64.561
Tunisia				
Mean	2.124	793.660	2912.750	250.438
Stdev	0.245	94.483	814.073	62.292

Stdev, CO_2, GDP, ENE, TOUR stand for standard deviation, carbon dioxide emissions, GDP, energy consumption and tourism receipts, respectively

Table 2 Pesaran (2004) cross-sectional dependence test

Variables	Mediterranean		Northern Mediterranean		Southern Mediterranean	
	CD test	*p* value	CD test	*p* value	CD test	*p* value
CO_2	7.123***	0.000	10.623***	0.000	2.17**	0.030
ENE	22.027***	0.000	15.967***	0.000	7.597***	0.000
GDP	44.286***	0.000	26.139***	0.000	18.3***	0.000
GDP^2	44.449***	0.000	26.19***	0.000	18.397***	0.000
TOUR	34.09***	0.000	21.445***	0.000	11.787***	0.000

The Pesaran (2004) cross-sectional dependence test is implemented on the null hypothesis of cross-sectional independence and the alternative hypothesis is that cross-sectional dependence exists

Significance at 1% level and 5% level are denoted with *** and **, respectively

consumption, real GDP and tourism receipts are cross-sectionally dependent. Taking this into account, we apply the CADF and CIPS panel unit root tests proposed by Pesaran (2007) and report the results of these tests for series of CO_2 emissions, energy consumption, real GDP and tourism receipts in Table 3. Based on the test statistics from the CADF test, we find that all variables examined are non-stationary at levels. Nevertheless, these variables are stationary after taking the first difference, which provide us evidence that the null hypothesis of unit root is rejected at 5% statistical significance level. For robustness, we also conduct the CIPS test. The results from the CIPS test are largely consistent with those of the CADF test, except that the results present some evidence of stationarity at levels for the tourism and energy consumption variables. Taken together, we conclude that all the variables are stationary at first difference; thus, all variables are characterized as an I(1) process.

Table 3 Panel unit root test results for the Mediterranean Countries

Variables	Mediterranean		Northern Mediterranean		Southern Mediterranean	
	CADF	CIPS	CADF	CIPS	CADF	CIPS
CO_2	−1.493	−0.816	−2.203	−0.973	−1.905	−1.562
ΔCO_2	−2.314***	−3.569***	−2.716***	−4.361***	−2.800***	−3.672***
ENE	−1.597	−1.521*	−1.914	−1.813**	−1.723	−1.275
ΔENE	−2.219**	−3.703***	−2.808***	−4.352***	−3.814***	−3.608***
GDP	−2.512	−1.403	−2.440	−1.216	−2.539	−1.462
ΔGDP	−2.507***	−2.770***	−2.762***	−3.892***	−2.349**	−2.804***
GDP^2	−2.490	−1.398	−2.490	−1.373	−2.501	−1.462
ΔGDP^2	−2.488***	−2.725***	−2.789***	−3.888***	−2.331**	−2.771***
TOUR	−2.165	−1.760**	−2.093	−1.896**	−1.258	−1.808**
ΔTOUR	−2.483***	−3.174***	−3.087***	−3.389***	−3.012***	−3.103***

The CADF and CIPS panel unit tests proposed by Pesaran (2007) are implemented using constant and trend variable in the model for difference variables and constant for level variables. The null hypothesis is that all the series have a unit root and the alternative hypothesis states that at least one of the series is stationary. Critical values are available upon request

Significance at 1%, 5% and 10% level are denoted with ***, **, and *, respectively. Δ is the first difference sign

Table 4 Panel cointegration tests

	All		Northern		Southern	
	Test statistic	*p* value	Test statistic	*p* value	Test statistic	*p* value
Panel v-statistic	−0.665	0.747	1.935**	0.027	−1.123	0.869
Panel rho-statistic	1.249	0.894	0.582	0.720	0.931	0.824
Panel PP-statistic	−6.890***	0.000	−3.168***	0.001	−5.526***	0.000
Panel ADF-statistic	−6.387***	0.000	−3.759***	0.000	−4.605***	0.000
Group rho-statistic	3.383	0.999	2.866	0.998	1.883	0.970
Group PP-statistic	−8.818***	0.000	−3.373***	0.000	−9.456***	0.000
Group ADF-statistic	−7.336***	0.000	−3.877***	0.000	−6.670***	0.000

The results of Pedroni (1999) panel cointegration tests are reported here. The null hypothesis states no cointegration ($\delta_i = 1$) and the alternative hypothesis is that $\delta_i < 1$

Significance at 1% and 5% level is denoted with *** and **

5.2 Panel cointegration results

Table 4 reports the results of Pedroni panel cointegration tests for the whole region and two subgroups, respectively. For all groups, most statistics are statistically significant. Given that group ADF and panel ADF tests are more powerful than other tests (Pedroni 2004), we conclude that the null hypothesis of no cointegration can be rejected at 1% significance level, indicating that the variables are integrated in all three groups of countries. Besides, Kao's (1999) residual cointegration test was also conducted to verify the cointegration relationship between the variables. Results

Table 5 Kao's (1999) residual cointegration test results

	t-statistics	*p* value
ADF-All	– 5.084***	0.000
ADF-Northern	– 5.599***	0.000
ADF-Southern	– 4.431***	0.002

The Kao's (1999) panel cointegration test is implemented, with the null hypothesis stating that there is no cointegration between these variables and the alternative hypothesis stating the existence of cointegration in the series

Significance at 1% level is denoted with ***

Table 6 Panel FMOLS estimates ($\ln CO_2$ is the dependent variable)

	ENE	GDP	GDP^2	TOUR
All				
FMOLS	0.813***	1.533***	– 0.083***	– 0.033
$R^2 = 0.456$	(0.000)	(0.002)	(0.003)	(0.163)
Northern				
FMOLS	0.522***	2.954***	– 0.149***	0.016
$R^2 = 0.815$	(0.000)	(0.000)	(0.000)	(0.764)
Southern				
FMOLS	0.945***	– 0.392***	0.026***	– 0.019***
$R^2 = 0.893$	(0.000)	(0.001)	(0.000)	(0.000)

p values are reported in parenthesis. Significance at 1% level, 5% level and 10% level are denoted with ***, ** and *, respectively

reported in Table 5 confirm the cointegrated relationship between the variables in our selected countries.

5.3 Panel FMOLS estimates

Table 6 presents the results of FMOLS estimates for all panels. Since all variables are taken logarithms before analysis, the estimated coefficients can be interpreted as long-run elasticities. As indicated in Table 6, the estimated coefficients are significant for all variables in all panels, except for the coefficients of tourism in the Mediterranean and Southern Mediterranean countries. Regarding the Northern Mediterranean panel, our results are similar to those for the global panel. As anticipated, the long-run elasticity of CO_2 emissions with respect to energy consumption is significantly positive, which means that a 1% increase in consumption increases emissions by 0.81%, 0.52% and 0.95% in the whole Mediterranean region, Northern Mediterranean countries and Southern Mediterranean countries, respectively. Moreover, considering the signs of the coefficients of GDP and GDP^2, the tourism-induced EKC hypotheses are confirmed in both the whole panel and the northern panel. The long-run elasticity of CO_2 emissions with regards to GDP is formulated as $\partial CO2/\partial GDP = 1.533–0.166$ GDP with the threshold GDP of 9.23 (in logarithms) in the Mediterranean countries, and $\partial CO2/\partial GDP = 2.954–0.298$ GDP with the threshold GDP of 9.91 (in logarithms) in Northern Mediterranean, which means that with the increase in per capita GDP CO_2 emissions increase until per capita GDP reaches 9.23 (All) and 9.91(Northern) and decrease afterward. In addition, tourism significantly negatively affects CO_2 emissions in the Southern Mediterranean countries where a 1% increase in tourism receipts decreases CO_2 emissions by 0.02%. For the other two panels, the impact of tourism on CO_2 emissions is mixed and insignificant at 5% significance level. Our findings parallel those reported by Lee and Brahmasrene (2013) for European Union and Zhang and Gao (2016) for China. However, our elasticity estimates contradict the findings of Katircioglu et al. (2014) for Cyprus, and de Vita et al. (2015) for Turkey.

A potential methodological concern existing in the FMOLS estimation in the EKC literature is the inclusion of powers of integrated variables in the estimation (Wagner 2008, 2015). To address this concern, Wagner (2015) and Wagner and Hong (2016) modify the FMOLS and extend it to the cointegrating polynomial regression (CPR). Our analysis is based on the fully modified OLS (FMOLS) estimator developed by Wagner (2015) for the following quadratic cointegrating polynomial regression (CPR):

$$CO_{2t} = \beta_0 + \delta t + \beta_1 GDP_t + \beta_2 GDP_t^2 + \beta_3 ENE_t + \beta_4 TOUR_t + \varepsilon_t \tag{6}$$

where CO_{2t},GDP_t, ENE_t, $TOUR_t$ are the log per capita values of CO_2 emissions, GDP, energy consumption, and tourism receipts, as defined in the earlier section. The underlying assumption is that GDP_t is an I(1) process, but GDP_t^2 is generally not. Additionally, ENE_t, $TOUR_t$, and ε_t are assumed to be stationary.

We first test the cointegrating polynomial relationship using two statistics introduced in Wagner (2015): CT for the null hypothesis of cointegration and $\hat{P}_u$for the null hypothesis of no cointegration.[4] The results given in Table 7 suggest that a cointegrating relationship only exists in a few countries. Specifically, the results show that the null of cointegration is not rejected, but meanwhile the null of no cointegration is rejected for nine countries including Cyprus, Italy, Malta, Spain, Turkey, Israel, Lebanon, Libya, and Morocco. Then we estimate the regression coefficients and compute the relevant t-statistics using OLS, FMOLS for CPRs and the nonlinear dynamic OLS (D-OLS) (Choi and Saikkonen, 2010). The D-OLS regression includes the first difference of y_t as below:

$$CO_{2t} = \beta_0 + \delta t + \beta_1 GDP_t + \beta_2 GDP_t^2 + \beta_3 ENE_t + \beta_4 TOUR_t + \beta_5 \Delta GDP_t + \varepsilon_t \tag{7}$$

Following Wagner (2015), the results for the countries which are characterized by a CPR relationship are reported in Table 8. An overview of Table 8 reveals that the results are subject to change from country to country. The results show that the existence of tourism-induced EKC is only validated in Cyprus, Lebanon and Libya at the country level. For the rest of countries with a CPR relationship, we failed to verify the

[4] For the definitions of CT and $\hat{p}_u$, we refer readers to Eqs. (13) and (15) on page 953 at Wagner (2015).

Table 7 The results of the tests CT for the null of cointegration and $\hat{P}_u$ for the null of no cointegration for 18 countries

Countries	CT	$\hat{P}_u$
Albania	0.0542	28.390
Croatia	0.0103	44.617
Cyprus	0.0196	100.711
France	0.0258	41.455
Greece	0.0702	25.043
Italy	0.0115	229.132
Malta	0.0618	665.012
Slovenia	0.0138	29.591
Spain	0.0651	209.814
Turkey	0.0109	317.580
Algeria	0.0138	14.670
Egypt	0.0490	3.5297
Israel	0.0073	135.6243
Lebanon	0.0814	70.980
Libya	0.0094	165.141
Morocco	0.0594	63.460
Syria	0.0429	16.991
Tunisia	0.0276	2.148
Critical values (5%)	0.106	52.952

existence of tourism-induced EKC. As can be seen from Table 8, energy consumption significantly positively affects CO_2 emissions in most of the countries, with the exception of Israel. The impact of tourism on CO_2 emissions is significant but differs across countries with mixed results. More specifically, it is interesting to note that tourism negatively impacts CO_2 emissions in five out of nine countries, including Malta, Spain, Turkey, Libya, Israel, at conventional significance levels based on CPR regressions. The results also show that the time trend in most countries is significantly different from zero. In addition, even if FMOLS and D-OLS produce similar estimation results for some countries, however, they produce divergent turning point values. Finally, we also graphically illustrate the tourism-induced EKC estimation results for the nine countries in Fig. 1. As shown in Fig. 1, the inverted U-shape curve is relatively observable in Cyprus, but for the other two countries the curve cannot be depicted clearly due to the sample constraints.

5.4 Panel causality results

The results of Dumitrescu–Hurlin's (2012) Panel Granger causality tests are presented in Table 9. For both the whole and Northern Mediterranean regions, as shown in Table 9, we find that there is one-way causality running from energy consumption to CO_2 emissions. In addition, we also document a bidirectional causality between energy consumption and CO_2 emissions, and between energy consumption and GDP. Bidirectional causality between energy consumption

Table 8 The coefficient estimates and the corresponding t-statistics (in parentheses) using OLS, FMOLS and D-OLS for the chosen countries

	δ	β_1	β_2	β_3	β_4	TP
Cyprus						
OLS	0.002	3.814	−0.193	1.040	0.205	19748
	(0.698)	(3.982)	(−4.054)	(9.806)	(4.592)	
FMOLS	0.000	4.439	−0.224	1.375	0.203	19793
	(0.937)	(25.939)	(−26.312)	(38.004)	(5.688)	
D-OLS	−0.002	8.091	−0.407	1.573	0.323	20604
	(−4.510)	(47.235)	(−47.719)	(41.711)	(8.610)	
Italy						
OLS	−0.010	−0.676	0.031	1.353	0.0635	57545
	(−4.949)	(−0.518)	(0.469)	(23.0309)	(0.910)	
FMOLS	−0.011	−2.449	0.116	1.576	0.104	37975
	(−28.396)	(−6.168)	(5.971)	(139.061)	(7.116)	
D-OLS	−0.014	−2.170	0.108	1.669	0.008	23234
	(−65.543)	(−9.564)	(9.711)	(149.317)	(0.528)	
Malta						
OLS	0.001	−2.387	0.121	1.144	−0.021	18525
	(0.226)	(−2.028)	(2.0505)	(19.108)	(−0.419)	
FMOLS	−0.003	−1.859	0.098	1.153	−0.051	13537
	(−2.584)	(−5.450)	(5.645)	(157.870)	(−6.994)	
D-OLS	−0.004	−1.810	0.096	1.143	−0.059	12835
	(−2.772)	(−5.010)	(5.218)	(90.709)	(−4.624)	
Spain						
OLS	− 0.016	− 2.754	0.154	1.731	− 0.342	7461
	(−7.623)	(−2.257)	(2.477)	(16.234)	(−2.337)	
FMOLS	−0.016	−2.574	0.145	1.707	−0.322	7307
	(−45.065)	(−14.048)	(15.803)	(527.891)	(−85.339)	
D-OLS	−0.017	−2.203	0.126	1.722	−0.294	6298
	(−54.874)	(−13.730)	(15.708)	(470.624)	(−68.882)	
Turkey						
OLS	−0.004	−0.137	0.009	1.040	0.010	1476
	(−1.511)	(−0.375)	(0.427)	(10.208)	(0.564)	
FMOLS	−0.001	−1.784	0.115	0.248	−0.025	2412
	(−1.294)	(−8.670)	(9.592)	(29.464)	(−2.254)	
D-OLS	−0.002	−0.857	0.055	0.721	−0.007	2550
	(−1.724)	(−4.348)	(4.776)	(171.229)	(−1.312)	
Israel						
OLS	−0.008	2.506	−0.128	1.168	0.022	17427
	(−2.802)	(0.581)	(−0.600)	(8.293)	(0.697)	
FMOLS	−0.024	−6.875	0.372	−0.400	−0.150	10375
	(−20.729)	(−2.201)	(2.401)	(−11.886)	(−3.583)	
D-OLS	−0.014	−3.460	0.183	0.416	−0.052	13013
	(−15.901)	(−1.388)	(1.478)	(22.098)	(−2.221)	

Table 8 (continued)

	δ	β_1	β_2	β_3	β_4	TP
Lebanon						
OLS	−0.006	7.402	−0.418	1.015	0.039	7010
	(−0.608)	(1.390)	(−1.385)	(6.506)	(1.748)	
FMOLS	−0.007	5.808	−0.326	0.958	0.036	7405
	(−7.698)	(4.699)	(−4.658)	(585.247)	(22.567)	
D-OLS	−0.017	5.351	−0.290	0.870	0.048	10207
	(−46.462)	(11.588)	(−11.089)	(2119.601)	(55.187)	
Libya						
OLS	−0.006	−0.983	0.061	1.019	−0.000	3044
	(−2.149)	(−2.122)	(2.295)	(10.247)	(−0.065)	
FMOLS	0.006	0.270	−0.014	0.332	−0.011	19058
	(8.030)	(1.022)	(−0.915)	(510.929)	(−6.836)	
D-OLS	−0.008	−0.812	0.053	1.035	0.003	2166
	(−12.729)	(−3.579)	(4.113)	(3696.665)	(2.936)	
Morocco						
OLS	−0.001	−3.172	0.211	0.704	0.097	1854
	(−0.226)	(−2.105)	(2.134)	(4.251)	(1.837)	
FMOLS	−0.006	−3.647	0.242	0.966	0.071	1879
	(−3.630)	(−4.228)	(4.240)	(138.756)	(8.555)	
D-OLS	−0.004	−5.320	0.352	1.189	−0.008	1916
	(−2.540)	(−6.390)	(6.392)	(177.558)	(−1.008)	

and economic growth implies the existence of the feedback hypothesis. Similar results were found in Gao and Zhang (2014) for Sub-Saharan African countries, Saboori and Sulaiman (2013) for Indonesia, Malaysia, Singapore, Philippines and Thailand, and Pao and Tsai (2010) for BRIC countries. Bidirectional causality between CO_2 emissions and economic growth is also well documented in the literature (see, for example, Pao and Tsai 2010; Jebli et al. 2015).

In contrast, turning to Southern Mediterranean, we find unidirectional causality running from both energy consumption and CO_2 emissions to GDP, respectively. We find no evidence of causality between energy consumption to CO_2 emissions. The relationship between economic growth, energy consumption and CO_2 emissions has been well documented in the literature since the pioneering study of Ang (2007). For comparison, our findings are consistent with Saboori and Sulaiman (2013) for Singapore and Thailand, and Katircioglu et al. (2014) for Cyprus.

We document unanimous unidirectional causality running from tourism to CO_2 emissions across regions, which implies that tourism is a contributor to climate change. However, there is no evidence documenting the reverse causality running from CO_2 emissions to tourism. In addition, for the whole and Northern Mediterranean, our results show that there is one-way causality running from tourism to energy consumption. Therefore, increased tourism in the whole and Northern Mediterranean regions may pose threats to the environment considering the unidirectional

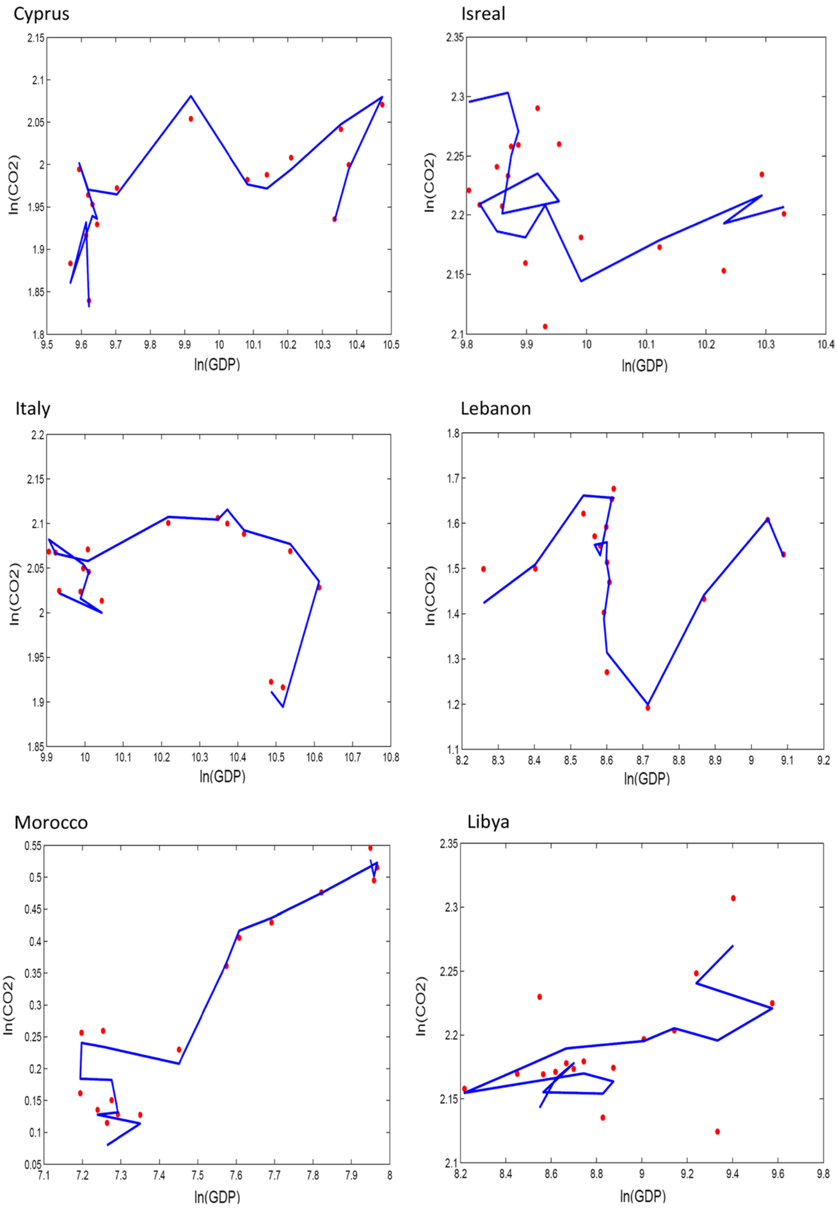

Fig. 1 EKC estimation results for Equation 6 for carbon dioxide emissions

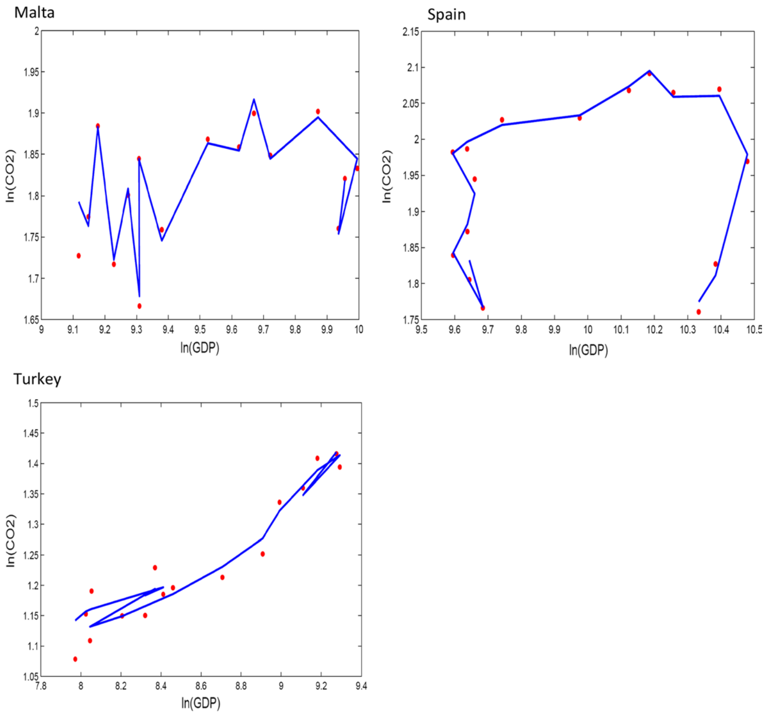

Fig. 1 (continued)

Table 9 Panel causality tests

Null hypothesis	All		Northern		Southern	
X → Y	Z bar statistics	*p* value	Z bar statistics	*p* value	Z bar statistics	*p* value
CO_2 → ENE	− 0.260	0.79	0.266	0.79	− 0.679	0.49
ENE → CO_2	2.431**	0.02	2.654***	0.01	0.678	0.50
CO_2 → GDP	5.114***	0.00	2.786***	0.01	4.556***	0.00
GDP → CO_2	4.086***	0.00	5.351***	0.00	0.147	0.88
CO_2 → TOUR	0.838	0.40	1.230	0.22	− 0.119	0.91
TOUR → CO_2	5.458***	0.00	5.243***	0.00	2.325**	0.02
ENE → GDP	3.134***	0.00	2.318**	0.02	2.110**	0.03
GDP → ENE	3.157***	0.00	3.856***	0.00	0.424	0.67
ENE → TOUR	0.184	0.85	0.964	0.34	− 0.801	0.42
TOUR → ENE	3.349***	0.00	3.898***	0.00	0.666	0.51
GDP → TOUR	1.243	0.21	1.935**	0.05	− 0.300	0.76
TOUR → GDP	7.715***	0.00	7.841***	0.00	2.801***	0.01

The results of the Dumitrescu–Hurlin's (2012) Panel Granger causality test are reported here. The null hypothesis states that X does not Granger cause Y and the alternative hypothesis states that X does Granger cause Y

Significance at 1% level and 5% level are denoted with *** and **, respectively causality from tourism to energy consumption and from energy consumption to CO_2 emissions. No evidence of causality in any direction between energy consumption and tourism growth was found in the Southern Mediterranean. Thus, regardless of the nature of related energy policy, its impact on tourism growth is negligent.

We also document evidence showing bidirectional causality between GDP and tourism in the Northern Mediterranean countries. Therefore, the feedback hypothesis is validated for these regions. The bidirectional causality between tourism and economic growth suggests that tourism and the broader economy interact and are jointly and simultaneously affected for the Northern Mediterranean countries. From an economic perspective, all countries in the region can enjoy the benefit from tourism. Our finding is similar to those of Durbarry (2004) for Mauritius, Dritsakis (2004) for Greece, Kim et al. (2006) for Taiwan, and Massidda and Mattana (2013) for Italy. For the other two panels of countries, we only found unidirectional causality from tourism to GDP without feedback, lending support to the growth hypothesis. For comparison purposes, our findings are similar to those of Balaguer and Cantavella-Jorda (2002), Lee and Chang (2008), and Fayissa et al. (2011).

6 Conclusion and Policy Implications

This paper investigates the relationship between CO_2 emissions, energy consumption, economic growth and tourism development using data for a panel of 18 Mediterranean countries over the period 1995–2010. In particular, the paper examines the tourism-induced EKC hypothesis for the sampled countries using the cointegrating polynomial regressions. Given the heterogeneity of the sampled countries, we added to the existing literature by creating two subgroups: Northern Mediterranean countries and Southern Mediterranean countries. Doing so will make our study contribute additional in-depth insights to policy makers in the Mediterranean region.

The results from the Dumitrescu–Hurlin Granger causality tests show that there is bidirectional causality between (i) CO_2 emissions and GDP; (ii) GDP and CO_2 emissions for the (Northern) Mediterranean countries. While for Southern Mediterranean, we document unidirectional causality running from CO_2 emissions and energy consumption to GDP, respectively. As for the relationship between tourism and GDP, we find that there is bidirectional causality in the Northern region, while for the southern and global panel we find one-way causality running from tourism to GDP.

We also show that unidirectional causality running from tourism to CO_2 emissions across regions. For the (Northern) Mediterranean region, there is one-way causality running from tourism to energy consumption and running from energy consumption to CO_2 emissions.

The estimated long-run elasticities indicate that tourism negatively significantly affects CO_2 emissions in the Southern Mediterranean region. A 1% increase in tourism decreases CO_2 emissions by 0.019%. For the developed countries on the northern rim of the Mediterranean, the impact is positive but insignificant. Results from CPR estimation show that tourism-induced EKC hypothesis is validated for three out of nine countries.

Given the above findings, our major policy recommendations are as follows: First, Mediterranean countries should continuously develop their tourism industries given their impact on economic growth. In the meantime, emphasis should also be placed on supportive tourism infrastructure development based on local actual situations. For the Southern Mediterranean, diversified economic development policy is more appropriate than a narrow one which focuses on the tourism sector in isolation. Second, Mediterranean countries should continue their sustainable tourism development to minimize its negative impact on the environment given that the tourism sector is a significant source of global climate change as suggested by our findings, particularly the Northern Mediterranean countries. Eco-tourism, as a new way of sustainable tourism development, should be encouraged and popularized. It can reduce emissions and environmental pollution in the process of transportation, accommodation and entertainment without adversely affecting the quality of tourism experience. Third, as recognition of tourism's energy impact on environments grows, proactive energy management policy should be enacted. Otherwise, CO_2 emissions associated with energy consumption in the tourism sector will adversely affect subsequent tourism demands and the development of tourism destinations.

Despite its potential contribution to the literature, there are some limitations associated with our study. Due to the data constraint such as the lack of tourism statistics data prior to 1995, our examined sample has a short time span thus the results should be interpreted with caveat. Future studies could use integrated data from multiple source and replicate our study at disparate geographical settings. In addition, this study solely focuses on CO_2 emissions. Given the potential impact of tourism on environment, it is imperative to investigate whether the findings are applicable to other pollutants, such as NO_x, SO_2, and $PM_{2.5}$, in the Mediterranean region. Finally, panel nonlinear cointegration methodology proposed by de Jong and Wagner (2016) can be applied in future studies to further address the panel econometric concerns in the wide EKC literature.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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