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The Role of Energy Transition and International Tourism in Mitigating Environmental Degradation: Evidence from SEE Countries

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Abstract: Since curbing the upward trend of energy consumption has become a global pursuit in achieving environmental sustainability, macroeconomic factors such as energy transition and international tourism may be of crucial importance in mitigating environmental degradation. However, the combined role of economic welfare, population, international tourism, and energy transition towards mitigating environmental degradation has not been investigated extensively. In this regard, this study looks at the combined interplay between these variables for a panel of ten southeastern Europe (SEE) countries, covering the period of 1997–2018 under the umbrella of the environmental Kuznets curve (EKC) phenomenon. Two indicators of environmental degradation, namely, ecological footprint and carbon intensity, were used in this study. The ordinary least squares (OLS) regression with Driscoll–Kraay (DK) and the panel Method of Moments Quantile Regression (MMQR) with fixed effects were used to disclose the following outcomes: firstly, the environmental degradation–economic welfare nexus firmly established an inverted U-shaped relationship, thereby depicting the validity of the EKC hypothesis. Secondly, energy transition and international tourism manifest negative effects: they induce environmental degradation. Thirdly, the impact of the population is positive but not significant. Given the empirical outcomes, energy transition and international tourism are proposed as critical to mitigating the environmental degradation of the inspected sample of countries.

Keywords: energy transition; EKC hypothesis; southeastern Europe; international tourism

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1. Introduction

As a result of economic emancipation and upward-trended energy use, environmental degradation is increasing and directly contributing to human-caused climate change. Some scholars believe that economic output is important in that it positively impacts welfare. However, since the last decade of the 20th century, there have been passionate discussions on the environmental impacts of economic growth under the prism of the EKC phenomenon, and loads of manuscripts support its existence [1–6]. These authors aimed to acknowledge the environmental Kuznets curve (EKC) hypothesis by investigating whether or not environmental quality decreases with economic welfare at low-income levels but increases at higher-income levels, such that an inverted U-shaped relationship between environmental degradation and economic welfare would be firmly established.

Most of these studies, however, focus on utilising carbon dioxide emissions as a proxy for environmental degradation, which only demonstrates a segment of it. Hence, to utilise an improved apprehension of the linkage between economic output, environmental degradation and energy use, this study proposes ecological footprints as a proxy for environmental depletion [7,8], which is in line with the studies of [9–11].

In the last few decades, various researchers and environmental policy agencies have paid substantial attention to the need for environmental quality evaluation and its key drivers. However, considering the tourism sector, which is among the dominant tertiary sectors in SEE countries, the interaction between environmental degradation, tourism and energy transition has been little studied [12–14]. Additionally, while an increasing number of economists are showing considerable interest in the association between energy use, economic welfare and environmental quality, fairly limited studies have examined this interrelation when considering international tourism and energy transition [15]. Given that the tourism sector has been acknowledged as one of the most energy-intensive sectors, an emerging number of studies have extensively analysed its role in environmental degradation [16–22].

The energy transition is a pillar of urban societies and a critical determinant of environmental quality. On one hand, energy use, the tourism sector and economic welfare are linked. It has long been axiomatic that energy use and international tourism contribute to economic welfare [23–29]. Moreover, the tourism sector is a driver of job growth and economic welfare. As a major source of employment, tourism has great positive economic, social and cultural effects on SEE countries. On the other hand, there is a need to disclose the environmental impacts of international tourism linked to transport and the higher need for energy [13,14]. Many countries encounter the negative environmental impacts of tourism associated with the overconsumption of natural resources. Tourism can cause the same forms of environmental issues as any other industry, including noise, air and water pollution, biodiversity loss, deforestation, etc. Pollution in the tourism industry comes from transport-related activities (travel to and from tourist attractions) and destination-related activities (hotels, restaurants and other activities). This is especially true for countries with lower economic welfare [30]. However, at the higher levels of economic welfare, international tourism is expected to be positively associated with environmental quality due to the energy transition that can relax environmental pressure. This is since generating energy that produces no or fewer greenhouse gas emissions reduces air pollution [29]. In addition, energy transition and transport transition are interlinked because transportation is among the top energy gluttons and represents an important aspect of international tourism [14].

In line with the above excerpt, the primary purpose of this study is to provide a better understanding of the interconnection between economic welfare, energy transition, population, international tourism and environmental degradation. The first objective of this study is to conjecture a relationship between economic welfare and two indicators of environmental degradation, namely, ecological footprint and carbon intensity, to inspect the validity of the EKC phenomenon. The second objective is to investigate whether environmental degradation could be mitigated through effective mechanisms such as energy transition and the promotion of renewable energy. The third objective is to provide fresh insight from ten SEE countries on the role of international tourism in environmental degradation.

The estimation strategy is structured as follows: (1) testing for panel cross-sectional dependence and slope homogeneity; (2) testing whether the variables are stationary using second-generation unit root tests; (3) examining the existence of long-term relationships among the variables using the panel co-integration; (4) utilising estimators of the ordinary least squares (OLS) regression with Driscoll–Kraay (DK) and the panel Method of Moments Quantile Regression (MMQR) with fixed effects to estimate the interconnection between the inspected variables.

The Motivation and Contribution of the Study

The tourism sector is an essential revenue generator and engine of sustainable development in many economies in the European Bank for Reconstruction and Development (EBRD) region, particularly in southeastern Europe (SEE). These countries are becoming visible as considerable tourist attractions, with leading tourist markets for Turkey and Greece, respectively, in 2018. With the accelerated growth of the tourism industry in the SEE region and increased energy use, there is a high potential that the industry is harming the environment, hence causing the region to seriously suffer from air quality issues.

Given the foregoing discussion, it is revealed that energy use, an economic upswing, population and the tourism industry have diverse outcomes on environmental degradation. SEE countries are affected by climate change and are primarily concerned with how to govern the relationship between people and nature sustainably. On this point, an examination of the interactions between international tourism, energy transition and environmental degradation is of considerable importance to both decision-makers and tourism professionals in the SEE region.

Subsequently, the study contributes to the literature on the EKC hypothesis in several ways. First, it contributes by analysing the environmental impact of economic welfare using the two indicators of environmental degradation: ecological footprint and carbon intensity. Second, the authors of this study are optimistic that this study is a pioneer in exploring the impact of variables such as energy transition and international tourism expenditures for passenger transport items using a sample of ten SEE countries. Third, this study uses modern panel data econometric techniques that consider the issue of cross-sectional dependence.

The other parts of the paper include previous studies on environmental degradation and other macroeconomic variables; sections that discuss the analytical model, methodology and data analysis; findings of empirical research and a discussion of the outcomes; and finally, the conclusion and policy implications.

2. Literature Review

This section of the paper delves into a summary of past empirical and theoretical studies on the interconnection between international tourism, economic output, energy transition and environmental degradation. The past literature sought to hypothesise the relationship among the inspected variables and is organised under the following sub-headings:

2.1. International Tourism and Environmental Degradation

Empirical and theoretical studies have acknowledged the deep connection between the tourism industry and environmental conditions. As indicated by [12], tourism development has led to lower carbon emissions. Ref. [13] reviewed the environmental impact of the tourism sector in the Mediterranean and recognised the critical role of the tourism sector in the economic development of the evaluated countries. This research provides fresh insight into the positive impact of sustainable tourism on the environment. In other words, sustainable tourism is efficient in reaching the environmental sustainability of Mediterranean countries.

In addition, Ref. [31] disclosed a long-run negative influence of the tourism industry on pollutant emissions. Given the findings, the authors proposed the popularisation of eco-tourism as a segment of sustainable tourism. Interactive policies should be portrayed to encourage advances toward energy efficiency. Similarly, Ref. [32] elaborated on the linkage between tourism and environmental degradation using a multivariate framework for a panel of 95 countries in the period 1995–2014. The findings, which cover high-income countries, demonstrated the significant negative impact of the tourism industry on pollutant emissions. By utilising tourism development, Ref. [12] assessed whether tourism development and innovation play a significant role in mitigating environmental degradation. Using the case study of G7 countries, the empirical outcomes of this study disclosed that tourism development aided in environmental quality in the period ranging from 2000 to 2019. Ref. [30] researched the connection between international tourism and pollutant emissions. Empirical evidence from G20 countries has portrayed the negative association between international tourism and carbon dioxide emissions, confirming the supportive role of the tourism industry in environmental quality. A study researching the environmental impacts of the tourism industry, by [14], showed that the tourism sector is effective in mitigating environmental degradation in Tanzania (1995–2017). In the vein of the aforementioned arguments, the following hypothesis has been theorised:

H1: International tourism is expected to exert a negative impact on environmental degradation.

2.2. Energy Transition and Environmental Degradation

Empirical outcomes have shown that energy transition aids in lessening the environmental degradation of the top carbon-emitting countries [26]. The authors further showed that a shift from fossil fuels to renewables is efficient in achieving environmental sustainability (1990–2016). Employing the Method of Moment Quantile Regression (MMQR) approach, Ref. [25] studied the environmental impact of the transition towards renewables. The authors provide a fresh insight from the Organisation for Economic Co-operation and Development (OECD) economies hindering the beneficial environmental impact of the transition towards clean energy sources. To curb the negative environmental impacts of high-carbon energy, the transition towards renewables is crucial. In this vein, Ref. [27] claimed that renewable energy could motivate countries to pick lower-carbon solutions, outlining that shifting away from fossil fuel energy sources toward renewable alternatives is of high priority to achieving low-carbon economies. Moreover, Ref. [33] contended that renewable energy aids in the environmental preservation of Southeast Asian countries. For the period 1990–2020, the authors focused on the role of international relations in promoting clean energy. The outcomes of this study necessitate the transition from high-carbon to low-carbon energy sources to mitigate current climate change issues. In the same vein, Ref. [23] discussed the dynamic interconnection between clean energy sources and the ecological sustainability of G7 countries. Employing the CS-ARDL approach, the authors clearly outlined the favourable environmental impact of renewable energy. In other words, the authors claimed that the transition towards low-carbon energy sources can alleviate environmental pressure. In light of these findings, we hypothesise the following relationship between energy transition and environmental degradation:

H2: Energy transition is likely to reduce environmental degradation.

2.3. Economic Output and Environmental Degradation

The validity of the EKC hypothesis has been comprehensively studied by an emerging strand of literature. Following the preliminary findings of [34] and the theory of the Kuznets curve [35], a plethora of studies have tested the existence of an inverted U-shaped curve on the emission–economic output nexus, for instance, [36] in China, Indian and Japan as well as [3] in high-income clusters. Similarly, Ref. [31] support the validity of the EKC hypothesis for the panel data of Mediterranean countries (1995–2010). In another study, Ref. [37] augmented the EKC model and revealed that economic output and squared economic output co-integrated with a proxy for pollutant emission from 1960 to 2009 in Turkey. Ref. [10] verified the validity of the EKC phenomenon while, in addition to their study, concluding that reducing ecological footprints fosters the need for environmental performance via the economic complexity index and trade openness variables. As explained by [38], there is an inverted U-shaped relationship between environmental emissions and gross domestic product for the period of 2005–2018 for 86 international tourism corporations. The corporate level faces a lack of data on pollutant emissions. The related coefficients with economic performance carry a positive sign. Simultaneously, the coefficient with squared economic performance is negatively significant. Results suggest that economic performance variables of tourism corporations pursue a U-shaped inverted link with pollutant emissions. In turn, the authors confirmed the robustness of the obtained findings embodied in several models. This conformed with the study of [32], who found that the EKC hypothesis holds using a multivariate framework for a panel of 95 countries in the period 1995–2014. Given the past literature's outcomes, the following interconnection is hypothesised:

H3: The authenticity of the EKC hypothesis is expected to be confirmed.

The existing literature predominantly reveals mixed findings due to different econometric techniques, different countries and different periods. These studies also lack any specific consideration of the sample of SEE countries. Therefore, our study adds to the literature by utilising the last available data and considering the tourism sector and energy transition. By doing so, we focus on testing the validity of the tourism-induced EKC hypothesis in the SEE countries to provide several policy recommendations that can be implemented to reach the sustainable development of the inspected region.

3. Model, Data and Methodology

This section presents the theoretical model for a group of ten SEE countries from 1997 to 2018. In addition, this section documents the data and estimation strategies used to evaluate the combined role of economic welfare, energy transition, international tourism and population in mitigating environmental degradation.

3.1. Theoretical Background and Model Specification

Given the review of the foregoing theoretical and empirical literature, this study adopts the theoretical background of the environmental Kuznets curve (EKC) hypothesis and focuses on the following model (Equation (1)):

$$EP_{it} = f\left(GDP_{it},\ GDP_{it}^2,\ POP_{it},\ ET_{it},\ IT_{it}\right) \tag{1}$$

where EP represents environmental degradation, measured in terms of ecological footprint (ECFP) and the carbon dioxide (CO_2) intensity of gross domestic product (GDP)—CI; GDP and GDP^2 refer to an indicator of economic welfare and its quadratic term, respectively; POP stands for population measured in terms of the employment-to-population ratio; ET represents energy transition; IT captures the impact of international tourism; i denotes the ten southeastern Europe (SEE) countries; t represents the analysed period. All the variables are expressed in logarithmic forms, and the transformed model can be specified as Equation (2):

$$L(EP_{it}) = \alpha_0 + \alpha_1 L(GDP_{it}) + \alpha_2 L\left(GDP_{it}^2\right) + \alpha_3 L(POP_{it}) + \alpha_4 L(ET_{it}) + \alpha_5 L(IT_{it}) + \varepsilon_{it} \tag{2}$$

The panel equation embraces the error term (ε_{it}). The intercept is denoted by α_0, whereas $\alpha_1 - \alpha_5$ stand for long-term elasticities. As indicated above, variables are expressed as a natural logarithm (L) to improve efficiency.

Various studies have proposed carbon dioxide emissions as an indicator of environmental degradation [20,21,39,40]. However, a limited number of studies have utilised ecological footprints as a holistic proxy for environmental degradation [9,11,36]. Indeed, there are limitations to carbon dioxide emission, which is a narrow term and only measures the emissions of carbon dioxide into the atmosphere. The ecological footprint is a more comprehensive term that quantifies humanity's demand for natural capital. Given these arguments, our study prioritises the ecological footprint over carbon dioxide emissions to measure environmental degradation. For the sake of a robustness check, this study employs carbon intensity analogues to the study of [41].

Energy use and international tourism are paramount pillars of urban societies and critical determinants of green growth. On one hand, energy use and the tourism sector are essential revenue generators in European countries, especially in SEE countries. These countries have received recognition as the world's top tourist destinations, particularly Türkiye and Greece. Other SEE countries also welcomed a significant number of tourists in the inspected period. As such, the tourism industry represents an important element of SEE's national economies due to its geopolitical location between Asia and western Europe, with unique ethnic and cultural diversity, coastlines, food and hospitalities that have a great potential to attract tourists worldwide. According to [42], the travel and tourism sector contributed 6.1% to the global GDP, clearly confirming the positive impact of tourism on welfare at the global level. Along with increased welfare, tourism is responsible for the generation of more jobs and higher levels of overall tourist expenditure [12,13]. Using tourism, the local population participates in community development, which has the potential to reduce social inequality.

On the other hand, there are severe unfavourable environmental impacts related to the tourism industry. Despite bringing into play positive economic impacts, the tourism sector contributes to greater energy use. Two aspects of the tourism sector are recognised as big energy gluttons: transport-related activities (travel to and from tourist attractions) and destination-related activities (hotels, restaurants and other activities). This is especially true in the early phases of economic welfare when the tourism industry is anticipated to be developing rather than developing [14,24]. However, it is expected that economic welfare will be followed by immense tourism sector growth, which is likely to increase the environmental quality of tourist destinations with time. The positive environmental impacts associated with international tourism expenditures are undoubtedly due to eco-innovations and increasing renewable energy that can cut greenhouse gas emissions associated with the fossil fuels used in international tourism [29]. Ecological sustainability and climate change mitigation must be reasoned with while fulfilling the increasing energy demand. Renewables-generated energy has beneficial environmental impacts and can help balance the inconsistency in the energy-mix market. It is greener in comparison to fossil fuels and, as such, plays a critical role in the transition towards carbon-neutral economies [28]. Moreover, eco-friendly tourist destinations can potentially attract green foreign direct investments that will support environmentally related research and development expenditure and eco-innovations. In such a way, international tourism can either increase or reduce ecological footprints (i.e., $\frac{\partial EP_{it}}{\partial IT_{it}} > 0$ or < 0), while energy transition is expected to reduce environmental degradation (i.e., $\frac{\partial EP_{it}}{\partial ET_{it}} < 0$), following the arguments presented by [27,30].

The conventional EKC hypothesis involves economic welfare. The signs of α_1 and α_2 are predicted to be positive and negative, respectively. If these coefficients are empirically confirmed, it suggests that an increase in economic welfare causes an increase in environmental degradation, which then declines after a subsequent period. Economic activities have a detrimental influence on the environment, lower land productivity, increase air pollution and worsen the aquatic environment. Addressing that ecological footprint relies on natural resources [41]; it would be justified to anticipate economic welfare's inverted U-shaped impact on environmental degradation. This means that when $\frac{\partial EP_{it}}{\partial GDP_{it}} > 0$ and $\frac{\partial EP_{it}}{\partial GDP^2_{it}} < 0$, an inverted U-shaped link between economic production and ecological footprint is demonstrated, thus confirming the validity of the EKC hypothesis [9,11].

The employment-to-population ratio is used as an indicator of the population factor in this study since an economically active population may be effective in explaining environmental degradation. The impacts of an economically active population on the environment can be outlined as follows: (1) an increase in population leads to a rise in the consumption of natural resources; (2) an increase in population is associated with a rise in waste products as a result of consumption (i.e., various pollutants). Following the arguments of [39,43], we expect a positive association between population and environmental degradation (i.e., $\frac{\partial EP_{it}}{\partial POP_{it}} > 0$).

3.2. Data

Following the geographical features of southeast Europe proposed by [44] and taking data availability constraints into account, our study selects ten SEE countries, namely, Albania, Bulgaria, Bosnia and Herzegovina, Greece, Croatia, Moldova, North Macedonia, Romania, Slovenia and Türkiye. This analysis excludes data from Serbia, Montenegro and Kosovo. Annual panel data for the period 1997–2018 were collected for the six variables. To achieve our study aims, we acquired data on real per capita GDP, population, energy transition and international tourism from the World Development Indicators [45]. The Global Footprint Network [46] database provides easy access to ecological footprint data, while the Organisation for Economic Co-operation and Development [47] database provides data on carbon intensity. The definitions of the underlying variables are shown in Table 1.

Table 1. Variables under investigation.

Variable	Description	Source
ECFP	Ecological footprint—global hectares per capita	GFN (2021)
CI	CO_2 intensity of GDP, CO_2 emissions per unit of GDP	OECD
GDP	Economic welfare (GDP per capita), constant 2015 USD	World Bank
POP	Population (employment-to-population ratio, 15+, total), %	World Bank
IT	International tourism, expenditures for passenger transport items	World Bank
ET	Energy transition (renewable energy consumption—% of total final energy consumption)	World Bank

The descriptive statistics of the underlying panel data are unveiled in Table 2. About 8458.30 (constant 2015 USD) is shown as the average real GDP per capita for the SEE nations. Greece reported the maximum real GDP per capita in 2007 (whereas Moldova reported a minimum value of 1307.98 in 1999). The mean value of the ecological footprint is about 3.38. SEE's largest total ecological footprint was recorded in Greece in 2000 (6.40), whereas the smallest total ecological footprint was recorded in Albania in 1997 (1.09). Minimum carbon intensity is reported for Albania in 1997, while Bulgaria and Moldova reported maximum values in 1997. As far as the energy transition is concerned, the maximum share of renewable energy in total energy is reported for Albania in 1997, while the minimum value is reported for Bulgaria in 1997. In terms of tourism expenditures for passenger transport items, the maximum value is reported for Turkey in 2018, whereas the minimum value is reported for Romania in 1997.

Table 2. Descriptive statistics.

Stat./Variable	ECFP	CI	GDP	POP	IT	ET
mean	3.38	0.30	8458.30	45.13	179000000	19.48
st. dev	1.15	0.13	6365.80	7.05	270000000	9.39
max	6.40	0.65	24073.00	62.37	1500000000	55.95
min	1.09	0.10	1307.98	29.40	6000000	3.81
skewness	0.433	0.686	0.981	−0.239	2.713	0.765
kurtosis	2.828	2.458	2.704	2.573	10.728	3.792

The correlation matrix of Table 3 displays a significant positive correlation between ecological footprint and: (i) economic welfare, (ii) population and (iii) international tourism. However, Table 3 outlines the negative correlation between energy transition and ecological footprint. A negative correlation is also shown between carbon intensity and: (i) economic welfare, (ii) population, (iii) international tourism and (iv) energy transition.

Table 3. Correlation matrix.

Variables	ECFP	CI	GDP	POP	IT	ET
ECFP	1					
CI	−0.084	1				
GDP	0.885 [a]	−0.385 [a]	1			
POP	0.170 [b]	−0.406 [a]	0.358 [a]	1		
IT	0.161 [b]	−0.224 [a]	0.292 [a]	0.015	1	
ET	−0.338 [a]	−0.531 [a]	−0.200 [a]	0.012	−0.208 [a]	1

Note: p-values in parentheses, [a] $p < 0.01$, [b] $p < 0.05$, [c] $p < 0.10$.

3.3. Methodology

The econometric strategy starts by examining the presence of cross-sectional dependency across the covered economies. Our study employs the cross-sectional dependency test (CD test) that was devised by [48]. SEE countries have deepened their economic ties with the European Union (EU), so there is the possibility of cross-country spillover effects among the ten economies. The study further employs the [49] test to check potential slope heterogeneity. Pesaran's second-generation unit root tests (individual cross-sectional augmented dickey–Fuller test (CADF) and cross-sectional augmented Im–Pesaran–Shin test (CIPS) [50] are used to check the stationary properties of the variables. The CIPS unit root test statistics might be expressed as Equation (3):

$$CIPS = N^{-1} \sum_{i=1}^{n} CADF \quad (3)$$

where CADF signals the cross-sectional Augmented Dickey-Fuller (CADF) regression that is further formulated as Equation (4):

$$\Delta y_{it} = \alpha_i + \beta_i y_{i,t-1} + \delta_{0i} \Delta \overline{y}_t + \delta_{1i} \Delta \overline{y}_{t-1} + \varepsilon_{it} \quad (4)$$

The null hypothesis is $H_0 : \beta_i = 0$ for all inspected countries, while the alternative assumes $H_1 : \beta_i < 0$.

Taking into account the cross-sectional implications, Westerlund's co-integration test [51] is utilised to test whether or not the inspected variables are co-integrated in the long term. Under the null hypothesis, the tests assume no co-integration, i.e., the dynamic long-run relationship does not exist in the inspected variables. Once the long-term connection has been validated, long-run estimates may be performed using the ordinary least squares (OLS) regression with Driscoll–Kraay (DK) standard errors. The potential issues of OLS regression with DK standard errors may be summarised as follows: (i) it produces only means estimates; (ii) it does not show the difference between inspected individuals at heterogeneous quantiles. To close these gaps, this study proposes the panel Method of Moments Quantile Regression (MMQR) with fixed effects formulated by [52]. The MMQR can be estimated using the following equations (Equation (5)–Model 1 and Equation (6)—Model 2):

$$Q_{LECFP}(\tau|X_{it}) = a_{1\tau} LGDP_{it} + a_{2\tau} LGDP_{it}^2 + a_{3\tau} LPOP_{it} + a_{4\tau} LET_{it} + a_{5\tau} LIT_{it} + \beta_i \quad (5)$$

$$Q_{LCI}(\tau|X_{it}) = a_{1\tau} LGDP_{it} + a_{2\tau} LGDP_{it}^2 + a_{3\tau} LPOP_{it} + a_{4\tau} LET_{it} + a_{5\tau} LIT_{it} + \beta_i \quad (6)$$

where β_i captures the unobserved individual effects.

4. Empirical Results and Discussion

To test the validity of EKC theory under the tourism context of the target SEE countries, the preliminary step in the present study is to perform the cross-sectional dependence test and heterogeneity analysis by taking the logs of the underlying variables (Table 4).

Table 4. Results of cross-sectional dependence (CD) and the slope homogeneity tests.

Test	Model 1	Model 2
Pesaran's test (2004)	4.178 [a]	3.964 [a]
Pesaran and Yamagata (2008) Δ	8.033 [a]	9.154 [a]
Pesaran and Yamagata (2008) Δ adj	9.729 [a]	11.086 [a]

Note: p-values in parentheses, [a] $p < 0.01$, [b] $p < 0.05$, [c] $p < 0.10$.

Since the early 2000s, trade liberalisation in the SEE countries has not only been a driver of economic growth but also an attempt to reconstruct relations among these economies.

Given the availability of sufficient interconnection capacity between the countries, cross-sectional dependence is likely to exist across SEE countries, which enables us to utilise the panel heterogeneity approach. According to Table 4, the null hypothesis of CD for both models is rejected at the 1% significance level ($p < 0.001$). Pesaran's cross-sectional dependence tests refute cross-sectional independence for our models. The null hypothesis on slope homogeneity is also rejected, necessitating the employment of panel data unit root tests, which outperform first-generation tests. Henceforth, the present study utilises individual CIPS tests to check panel figures for a possible unit root problem with constants and trends, as shown in Table 5.

Table 5. Unit root tests overlook the cross-sectional dependence.

Var.	Levels	1st Diff
	Trend and Constant	**Trend and Constant**
LECFP	−3.38 [a]	−5.42 [a]
LCI	−2.59	−4.52 [a]
LGDP	−3.25 [a]	−3.39 [a]
$LGDP^2$	−3.27 [a]	−3.38 [a]
LPOP	−1.92	−2.99 [b]
LIT	−2.09	−4.16 [a]
LET	−3.00 [b]	−4.41 [a]

Note [a] $p < 0.01$, [b] $p < 0.05$, [c] $p < 0.10$. Δ—the first difference sign. L—natural logarithm.

Based on the test statistics from the CIPS test, we report that the carbon intensity, population and international tourism proxy variables show unit root problems at their levels. By contrast, ecological footprint, economic welfare, and energy transition are stationary at their levels since their test statistics values are lower than critical. Meanwhile, there is no longer evidence of unit roots after the first difference of all the variables.

Having affirmed the evidence of CD and the stationarity of the variables, this study employed Westerlund's co-integration technique [51] to ascertain whether or not a long-term relationship exists between the underlying variables. The result is displayed in Table 6.

Table 6. Tests of co-integration.

Test	Statistic	Model 1	Model 2
Westerlund (2007)	Gt	−4.763 [a]	−4.192 [a]
	Ga	−12.965	−9.555
	Pt	−14.389 [a]	−11.134 [a]
	Pa	−12.912	−8.238

Note [a] $p < 0.01$, [b] $p < 0.05$, [c] $p < 0.10$.

The Westerlund co-integration tests revealed the existence of co-integration among the variables, rejecting the null hypothesis of no co-integration. Hence, it can be concluded that there is a long-term association between ecological footprint, economic welfare, population, energy transition and international tourism in Model (1), as well as between carbon intensity, economic welfare, population, energy transition and international tourism in Model (2).

After verifying the long-term interconnection between the panel figures, the study further proceeded to estimate the long-run elasticities using the results of the OLS regression with DK standard errors and MMQR estimators that are displayed in Table 7.

Table 7. OLS-DK and MMQR estimators.

Mod.	Var./QR	OLS		0.1 QR		0.3 QR		0.5 QR		0.7 QR		0.9 QR	
		Coef.	$p > z$	Coef.	$p > z$	Coef.	$p > z$	Coef.	$p > z$	Coef.	$p > z$	Coef.	$p > z$
1 LECPF dep. var.	LGDP	0.984 [a]	0.004	0.368	0.562	0.699 [c]	0.099	1.002 [a]	0.004	1.218 [a]	0.002	1.588 [b]	0.012
	$LGDP^2$	−0.032 [c]	0.091	0.004	0.913	−0.016	0.534	−0.033	0.100	−0.046 [c]	0.051	−0.068 [c]	0.067
	LPOP	−0.032	0.824	−0.223	0.225	−0.120	0.328	−0.026	0.792	0.040	0.729	0.156	0.397
	LIT	−0.019 [a]	0.005	−0.027 [a]	0.006	−0.023 [a]	0.001	−0.019 [a]	0.000	−0.016 [b]	0.011	−0.011	0.264
	LET	−0.171 [a]	0.000	−0.157 [a]	0.000	−0.164 [a]	0.000	−0.171 [a]	0.000	−0.176 [a]	0.000	−0.184 [a]	0.000
2 LCI dep. var.	LGDP	2.513 [a]	0.002	4.022 [a]	0.002	3.247 [a]	0.000	2.423 [a]	0.000	1.800 [a]	0.005	1.308	0.117
	$LGDP^2$	−0.178 [a]	0.000	−0.264 [a]	0.000	−0.220 [a]	0.000	−0.173 [a]	0.000	−0.137 [a]	0.000	−0.109 [b]	0.022
	LPOP	−0.020	0.855	−0.137	0.673	−0.077	0.722	−0.013	0.927	0.035	0.830	0.073	0.733
	LIT	−0.022 [a]	0.000	−0.025	0.172	−0.023 [c]	0.053	−0.022 [a]	0.007	−0.021 [b]	0.021	−0.020 [c]	0.094
	LET	−0.277 [a]	0.000	−0.294 [a]	0.000	−0.285 [a]	0.000	−0.276 [a]	0.000	−0.269 [a]	0.000	−0.263 [a]	0.000

Note [a] $p < 0.01$, [b] $p < 0.05$, [c] $p < 0.10$. QR = quantile regression.

As reported in Table 7, the outcome of OLS-DK estimators signals a statistically significant positive coefficient with economic welfare and a negative coefficient with its squared term. These findings clearly show the inverted U-shaped linkage between ecological footprint and economic welfare in Model 1. Similarly, Model 2 estimates the link between carbon intensity and economic welfare. The coefficients associated with welfare and its squared term give credence to the validity of the EKC hypothesis in the sample of ten SEE countries in the period ranging from 1997 to 2018. Just as projected, the indicators of environmental degradation were significantly influenced by economic welfare and its squared term. In terms of the population, it is worth mentioning that the coefficient with the employment-to-population ratio was not significant for both models using the OLS-DK estimator. Our findings reported in Table 7 show that international tourism and expenditures for passenger transport items were negatively associated with the ecological footprint. Similarly, the findings of Model 2 displayed a negative association between carbon intensity and international tourism. In addition, the findings of OLS-DK estimators outline a negative association between energy transition and environmental degradation using two consecutive proxies: ecological footprint and carbon intensity.

To overcome the potential drawbacks of the OLS-DK estimator, our study further uses panel quantile regression. Table 7 and Figure 1 outline the outcomes of the panel quantile regression. According to the MMQR findings, economic welfare positively influences ecological footprint, while the coefficient, with its squared term, is reported to be negative. The findings of panel quantile regression precisely confirm the authenticity of the EKC phenomenon in SEE countries (H3). The coefficient of economic welfare showed an increasing trend in different quantiles, while the coefficient of its square term showed a decreasing trend. The two coefficients were significant at higher quantiles, suggesting that the SEE countries with higher levels of ecological footprint experience positive environmental impacts on economic welfare. As far as Model 2 is concerned, Table 7 shows that our results are robust to the proxy for environmental degradation. In other words, the coefficients with economic welfare and its squared term are positive and negative, respectively, confirming the inverted U-shaped linkage between economic welfare and carbon intensity. As opposed to Model 1, in Model 2, the coefficients with economic welfare displayed a decreasing trend, whereas the coefficients with the squared term outlined an increasing trend. These findings are consistent with [9,36,39].

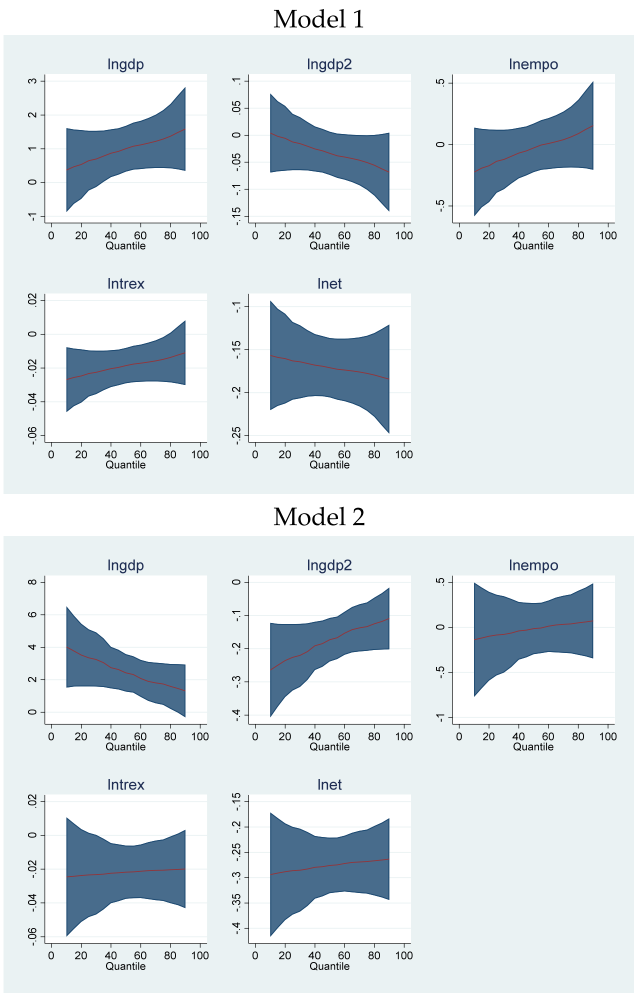

Figure 1. MMQR plots. Note: lnempo = LPOP, lntrex = LIT.

Second, the employment-to-population ratio is used as an indicator of the population in this study. Model 1 suggests that the impact of the employment-to-population ratio on ecological footprint is not statistically significant. Although the coefficient displays a rising trend for various quantiles, there is no significant relationship between the employment-to-population ratio and ecological footprint. Similarly, the relationship between carbon intensity and the employment-to-population ratio is observed in Model 2. Our findings outline the increasing trend; however, no significant impact of the employment-to-population ratio on carbon intensity was reported for the sample of ten SEE countries. The findings support the results of [22,41]. The highest coefficients were, however, reported for the countries with high levels of ecological footprint and carbon intensity. It can be reasoned based on the fact that an economically active population strongly increases the consumption of natural resources in countries with higher ecological footprints and carbon intensity.

International tourism is negatively associated with an ecological footprint in Model 1. Overall, from a statistical perspective, the impact of international tourism is statistically significant and negative at lower (0.10–0.30), middle (0.40–0.60) and higher (0.70–0.80) quantiles, with the coefficient increasing from around -0.027 at the 10th quantile to -0.011 at the 90th quantile. That said, in international tourism, expenditures for passenger transport items in countries with higher levels of ecological footprint significantly decrease environmental degradation (H1). Similarly, our findings show the negative association between energy transition and ecological footprint in Model 1. In addition, the association between international tourism and carbon intensity was analysed in Model 2. The coefficients displayed a decreasing negative trend. To evaluate the robustness of our baseline model, we have further analysed the link between energy transition and carbon intensity. The significant negative association between environmental degradation and energy transition for all quantiles is worth mentioning (H2). The findings of our study are strongly supported by [25–28]. The negative coefficients with international tourism and energy transition clearly show that ecological sustainability and climate change mitigation are validated while fulfilling the increasing demand for energy in tourism. In addition, SEE countries are increasing investment in renewable energy, which is proven in our study to have a beneficial environmental impact. Herein, by moving from fossil fuels to renewable energy, SEE countries will manage to neutralise the negative environmental impact of transport-related and destination-related tourism activities.

5. Conclusions and Policy Implications

This study has analysed whether energy transition and international tourism can be efficient in mitigating the environmental degradation of ten SEE countries. To actualise the interconnection between ecological footprint and carbon intensity as indicators of environmental degradation, econometric techniques were used. This included the exploration of the presence of cross-sectional dependency and slope homogeneity to address the heterogeneity of the countries in the SEE region, testing for the stationarity of the data using the CIPS unit root test and establishing the evidence of a co-integration relationship using ordinary least squares (OLS) regression with Driscoll–Kraay (DK) and the panel Method of Moments Quantile Regression (MMQR) with fixed effects. These were used to estimate the long-term elasticities of environmental degradation concerning the selected macroeconomic variables.

The authors found five primary empirical results: i. economic welfare, squared economic welfare, energy transition, international tourism, population and environmental degradation are in a long-run equilibrium relationship; ii. economic welfare initially increases the environmental indicator but later mitigates environmental degradation, validating the tourism-induced EKC hypothesis; iii. energy transition and environmental degradation are negatively and significantly related; iv. international tourism relaxes the environmental pressure of SEE countries, and v. there is no significant relationship between population and environmental degradation.

The findings of our study suggest some policy implications: the confirmation of the validity of the tourism-induced EKC hypothesis reveals that SEE countries are dedicated to minimising environmental damage and conserving natural resources for future generations. The tourism industry is the stimulus for the SEE countries' revenue; hence, decision-makers should balance this industry with the aim of sustainable development by preserving natural resources and developing tourism infrastructure that will attract more tourists and promote environmental protection. Moreover, SEE countries need to concentrate on improving energy efficiency, energy conservation and the empowerment of electricity consumers to lower their ecological footprint. This study has analysed the validity of tourism-induced EKC for an aggregated ecological footprint; however, analysing the ecological footprint of key industries within specific sectors would guide sectorial energy efficiency policies more effectively. Herein, future studies may consider the ecological footprint for various economic sectors and consider sustainable energy systems.

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