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# Journey to Discover the Footprint of Tourism from the Perspective of Ecological Modernization

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## Ekolojik Modernleşme Perspektifinden Turizmin Ayak İzini Keşfetme Yolculuğu

### Abstract

This research aims to investigate tourism's environmental impacts through the lens of Ecological Modernization Theory (EMT). The study examines how tourism development, economic growth, green innovation, and government effectiveness affect the environment. According to the Augmented Mean Group (AMG), the results revealed that tourism growth and economic expansion negatively impact the environment. In contrast, green innovation and government effectiveness have positive effects. The study also provides country-specific coefficient estimates. The empirical results support the validity of the EMT across the panel, specifically for Germany, France, the UK, and Russia.

**Keywords** : Environmental impact, Tourism, Ecological Modernization Theory, Dynamic Panel Data Analysis, AMG Estimator.

**JEL Classification Codes** : Q51, Q57, Z30, C33.

### Öz

Bu araştırmanın amacı, turizmin ekolojik etkilerini Ekolojik Modernleşme Teorisi (EMT) merceğinden araştırmaktır. Çalışma, turizmin gelişiminin, ekonomik büyümenin, yeşil inovasyonun ve hükümet etkinliğinin çevreyi nasıl etkilediğini incelemektedir. Sonuçlar, Artırılmış Ortalama Grubuna (AMG) göre hem turizm büyümesinin hem de ekonomik genişlemenin çevre üzerinde olumsuz bir etkiye sahip olduğunu ortaya koydu. Buna karşılık, yeşil yenilik ve hükümet etkinliğinin olumlu etkileri vardır. Çalışma ayrıca ülkeye özgü katsayı tahminleri de sunmaktadır. Ampirik sonuçlar EMT'nin panel boyunca ve özellikle Almanya, Fransa, Birleşik Krallık ve Rusya için geçerliliğini desteklemektedir.

**Anahtar Sözcükler** : Çevresel Etki, Turizm, Ekolojik Modernleşme Teorisi, Dinamik Panel Veri Analizi, AMG Tahmincisi.

## 1. Introduction

Since the 1980s, attention to tourism as a catalyst for economic progress in developing countries, coupled with the expansion of mass tourism from Europe and the Mediterranean to new areas such as Southeast Asia, the Far East, Africa, and the Caribbean, has stimulated academic research into the environmental consequences of tourism (Holden, 2016: 68-69). While 277 million tourists travelled worldwide in 1980, 1,460 million tourists travelled in 2019, generating tourism revenues of US$1,481 billion. At the beginning of the 21st century, tourism became one of the most economically productive sectors, supporting one out of every ten jobs globally and contributing to 10.4 per cent of the globe's gross domestic product (UNWTO, 2020). Over time, the natural environment has been negatively affected by the increasing mobility of tourism and the diversification of tourism activities. The environment is one of the critical elements of the tourist experience. Tourists look for attractive and distinctive environments that can support their activities. They visit natural beauties, historical and archaeological sites, open-air museums, national parks, and marine and coastal areas (Hillery et al., 2001: 854). Tourist-oriented activities put pressure on the environment, causing it to become polluted, damaged, or unusable. (Andereck, 1993: 77-78; Becken et al., 2020: 1605). The environment is also needed by tourism enterprises such as accommodation, transport, catering, recreation, tour operators and travel agencies. Tourism enterprises, which cause various types of pollution (air, water, noise, traffic, soil, etc.) and waste problems using natural resources and surplus carbon-based energy, threaten the maintenance of environmental quality (Gössling & Hall, 2006: 13-14; Buckley, 2011: 401; Jaz et al., 2023: 117).

Telfer & Sharpley (2008) describe the potential development contribution of tourism and environmental damage as the "tourism development dilemma". According to the authors, tourism catalyses economic and social development in destinations. Physical, social, and cultural attractions are the elements of tourism. On the other hand, the tourism sector has the potential to degrade or destroy the natural environment. Zhang & Liu (2019) state that the transport sector, directly related to tourism activities, is responsible for more than 75% of total $CO_2$ emissions. Total global $CO_2$ emissions increased by 1% in 2022 compared to 2021. This represents a new record high of 36.6 billion tons of $CO_2$ (<www.globalcarbonproject.org>, 2022). In 2022, average monthly $CO_2$ levels were observed to exceed 420 parts per million for the first time. The increase is about 100 times faster than in all previous geological periods. (<www.noaa.gov>, 2022). Razzaq et al. (2021) emphasise that the overconsumption of natural resources due to tourism increases the ecological footprint (EF) and thus depletes the biological capacity. The EF is the ecological capacity required to generate the resources used and to manage the waste produced by individual and company activities, considering current technology and resource management. It is also accepted as an indicator of whether the planet is living within the limits of self-renewal by comparing biological capacity. The world's biological capacity in 2022 is 1.5 global hectares per person, while EF is 2.7 global hectares per person. In 2022, total biological capacity increased by 0.4% compared to the previous year, while total EF increased by 1.2% simultaneously. (<www.wwf.org>, 2022).

The theoretical framework explaining environmental damage is based on Schnaiberg's (1980) Treadmill Production Theory. According to this theory, new production systems after 1945 are capital-intensive. Due to large production scales, more material inputs are needed, and more energy is used. As a result, companies' growing population and efforts to control the extraction of raw materials and the sale of consumer goods to increase profits and market share lead to more significant depletion of natural resources incompatible with the ecosystem and a range of environmental problems. This theory links environmental degradation to economic growth factors. Mol & Sonnenfeld (2000) are among those who have argued that it is possible to remedy environmental problems while at the same time achieving economic growth. This systems-based approach, which came to the fore with the studies of Huber (1982) and Janicke (1985) and has evolved, is called Ecological Modernization Theory. According to Theory, environmental degradation caused by modernisation can be solved by using more modern technology. In other words, economic and environmental goals can be reconciled. This consensus is achieved by supporting research into clean technologies and green innovation, by taxing energy, transport, industrial pollution, and water use, and by reducing labour costs by using the revenue from these taxes for social security payments (Gouldson & Murphy, 1997: 82). To do this, it is suggested that the state should steer industry towards ecological, green innovations that will raise the standard of environmental protection. Regarding achieving economic growth without causing environmental problems, EMT plays a central role in technology and government.

An extensive literature has emerged that empirically investigates whether it has an impact on the environment, including growth theories (Grossman & Krueger, 1995; Apergis & Payne, 2010; Özcan et al., 2020), sustainable development model (Bilen, 2008; Khan et al., 2019), treadmill production theory (Stretesky et al., 2013; Long et al., 2018; Ahmed et al., 2022), environmental Kuznest Curve (EKC) hypothesis (Fodha & Zaghdoud, 2010; Örnek & Türkmen, 2019; Akbaş & Lebe, 2023) and STIRPAT environmental model (Lin et al., 2009; Bargaoui, 2014; Jahanger et al., 2022). With the rapid development of tourism, the sector was also included in the models as a variable (Deniz, 2019; Jebli et al., 2019; Abbasi et al., 2021; Karadağ, 2021; Yurtkuran, 2022; İlban & Liceli, 2022). However, the literature on empirical models that include tourism is relatively new compared to other studies. In addition, if necessary, measures regarding tourism are not taken in time that disrupts the ecosystem and the natural environment. It may lead to more destructive consequences for the sector's sustainability and humanity. Therefore, new studies are needed to diversify solutions and policy recommendations to balance tourism's economic benefits and potential environmental threats. Thus, this study's core objective is to explore tourism's environmental impact by formulating an econometric framework in line with EMT's propositions and to seek evidence of whether EMT is supported. Based on this primary objective, the study aimed to assess the dynamic links between modernisation, tourism, and environmental stability and to measure the impact of tourism activities on environmental damage quantitatively. EMT emphasises the importance of technological progress in solving environmental problems, adopting environmentally friendly policies and management strategies, addressing environmental issues globally, and social participation and awareness.

The effort to establish an econometric model by combining the elements of EMT with time and space factors and to obtain quantitative estimates through multidimensional analysis is an essential novelty in adopting scientific and data-based approaches. In this context, it is also one of the objectives that the results of the panel data analysis will contribute to predicting future environmental trends, developing effective policies and management strategies in this area, and supporting global decision-making processes by stakeholders in the tourism industry.

The study is expected to significantly contribute to the current scientific discourse in three main areas. First, it examines the environmental impact of tourism within the EMT framework. In this sense, it differs from other studies that intensively use growth theories, the EKC hypothesis and STIRPAT models. The inclusion in the econometric model of government effectiveness and green innovation variables, which are directive according to EMT, can be the cornerstone of new insights and discussions. As far as we know, the model to be created can be a candidate for taking its place among the first examples of the literature. Second, using EF data to represent the environment in the empirical analysis is preferred. In empirical studies, environmental damage caused by tourism is mainly associated with the transport sector and the environmental factor is represented by $CO_2$ emission rates. However, the environmental damage caused by tourism involves more than air pollution. Hence, the comprehensiveness of environmental deterioration goes beyond being solely encapsulated by $CO_2$ emission rates. Accordingly, EF data is regarded as a comparatively superior metric. Furthermore, specialised long-term elasticity coefficients are computed for European nations experiencing substantial tourist influx. Delving into country-specific analysis holds significance in enhancing the diversity of policy formulation. Consequently, this investigation employs the AMG estimator, introduced by Eberhardt & Teal (2010), to ascertain long-term elasticities.

After the introductory section, the second segment provides instances of empirical research within the existing literature, highlighting the interplay between tourism and its environmental implications. The third section discusses the utilised methodology, while the fourth section presents the unveiled research outcomes. The conclusive section deliberates upon these findings and assesses potential policy recommendations.

## 2. Literature Review

Indeed, examining the ecological consequences of tourism's growth is pivotal for identifying, monitoring, and formulating plausible remedies. However, the research evidence on the environmental impacts of tourism is not sufficient and explicit (Katırcıoğlu et al., 2020: 392; Shahbaz et al., 2021).

In most empirical studies, including the tourism factor, the environmental impact has been expressed regarding $CO_2$ emissions. Raza et al. (2016) delved into the ramifications of tourism on environmental degradation within the United States, spanning from 1996(1) to 2015(3), utilising the wavelet transform methodology. This technique enables the dissection of temporal series into diverse frequency components. The empirical insights divulged that tourism wields a predominantly positive impact on $CO_2$ emissions across short, medium, and long-term timeframes. Using the FMOLS technique, Balsalobre-Lorente et al. (2020) probed the interconnections among international tourism expenditure, globalisation, and $CO_2$ emissions per capita across 1994 and 2017 across OECD nations. The model encompassed economic growth, energy consumption, and globalisation as explanatory factors. The investigation was complemented by cointegration tests, including Pedroni, Kao, and Westerlund, alongside a causality test by Dumitrescu and Hurlin to unearth the long-term relationship dynamics. The empirical findings, derived from the FMOLS estimation, ratified an inverted U-shaped association between international tourism expenditure and environmental deterioration, affirming the EKC hypothesis. Tandoğan & Genç (2019) proved the existence of the relationship between the number of tourists and $CO_2$ emissions with the RALS-Engle and Granger co-integration tests for the period 1980-2014. Tandoğan and Genç (2019) exposed the coexistence of a cointegration relationship between tourist numbers and $CO_2$ emissions through RALS-Engle and Granger cointegration tests from 1980 to 2014. The ensuing causal analysis revealed bidirectional causality between the two variables, emphasising the dual-edged impact of tourism. While acknowledging the economic benefits of tourism, the authors emphasised the imperativeness of mitigating environmental degradation through sustainable practices and renewable energy promotion. Zhang et al. (2019) explored tourism's interplay with environmental degradation, logistics, transport operations, and crime rates in Thailand from 2001 to 2017. The research, utilising the ARDL method, highlighted intricate relationships. Logistics and transport operations positively correlated with tourism, while elevated carbon emissions and fossil fuel utilisation displayed adverse connections. The study underscored the critical role of deforestation and inadequate sustainability in influencing tourism and recommended enforcing green practices in the logistical and transport realms. Ahmad et al. (2019) examined the relationships between tourism and pollution in Indonesia, the Philippines, and Vietnam from 1995 to 2014. The FMOLS approach was employed, utilising data encompassing $CO_2$ emissions, tourist arrivals, per capita income, and energy consumption. The outcomes corroborated the adverse influence of tourism on the environment within Indonesia and the Philippines while conversely indicating an improvement in environmental quality within Vietnam. Notably, this outcome underscores the nuanced regional diversity in the relationship, contingent upon distinct country-specific attributes and pertinent environmental protection policies. Gulistan et al. (2020) analysed the relationship between the environment and growth, energy consumption, trade openness, and tourism. Their study spanned 112 countries from 1995-2017, stratified by income and region. Utilising Pooled Least Squares and Generalized Least Squares methods, the research established the comprehensive greening effect and delineated income levels where environmental quality improved. The intricate interactions unfolded, indicating that economic growth, energy consumption, and tourism bore adverse effects, while trade openness displayed no significant statistical impact. Haseeb & Azam (2021) explored the interrelations involving tourism, corruption, democracy, and environmental degradation. By applying FMOLS analysis and Dumitrescu-Hurlin causality tests, data spanning 1995-2015 were examined across country groupings. The study divulged significant contributions of corruption and tourism to $CO_2$ emissions, with the influence being more pronounced in low-income countries. Complex causal relationships were also unveiled, emphasising the intricate interplay between democracy, corruption, tourism, and $CO_2$ emissions. Ballı (2021) scrutinised the tourism and environmental degradation across 32 OECD countries, leveraging the Emirmahmutoğlu-Köse panel estimation technique. Notably, the outcomes highlighted the joint escalation of $CO_2$ emissions. A unidirectional causality emerged from tourism to $CO_2$ emissions. The nuanced country-level analysis uncovered bidirectional relationships in some nations and unidirectional influences in others, underscoring the multifaceted nature of these dynamics. Liu et al. (2022) delved into the spatial spillover effect of tourism expansion on $CO_2$ emission, scrutinising panel data from 70 nations spanning 2000-2017. The empirical results revealed a dualistic influence of tourism, encompassing a direct positive effect and an indirect negative effect on environmental pollution. This indirect impact was noted to surpass the positive direct effect, ultimately leading to a substantial overall detrimental effect. Population density, trade openness, and economic growth were found to modulate environmental pollution significantly.

The use of EF to represent the environment in empirical analysis is relatively new. It is difficult to comment on the general trend by evaluating the results of these studies, which are very few. Godil et al. (2020) added to the discourse by probing the interplay of globalisation, tourism, and environmental degradation in China (1978Q1-2017Q4). The findings highlighted a complex interplay, with economic growth catalysing emissions and environmental impact assessments confirming their existence. Intriguingly, the nuanced influence of tourism on environmental quality emerged, while globalisation's impact was predominantly adverse. Karadağ (2021) explored the repercussions of tourism expansion on the environment by analysing Türkiye's tourist numbers and EF from 1990-2016. Employing FMOLS and DOLS techniques for long-term coefficient estimation, the research underscored the exacerbating impact of increasing tourist numbers on environmental degradation. Proposals for sustainable development were rooted in the diversification of tourism offerings. Nathaniel et al. (2021) sought to understand the environmental impacts of tourism, growth, natural resource rent, urbanisation, and energy in the ten most visited tourist destinations between 1995 and 2016. Employing Westerlund's cointegration technique and CUP-FM and CUP-BC estimators for long-term coefficient determination, the research illuminated intricate relationships. Economic growth was unveiled as a determinant with a negative relationship with urbanisation and natural resources. Kutlu & Kutlu (2022) investigated the influence of tourism activities on EF using the ARDL bounds test method, encompassing data from 1970-2017 in Türkiye. The study disclosed that tourism expenditures and energy consumption engender long-term increases in ecological footprint, while per capita income and tourism revenues exhibit inverse effects. İlban & Liceli (2022) employed the Dumitrescu-Hurlin panel causality test to assess the interplay between EF and tourist influx across the top ten countries attracting the most tourists in 2020. The findings delineated a bidirectional causal relationship between EF and tourist numbers, prompting the suggestion of sustainable and alternative tourism strategies.

Han et al. (2022) analysed Türkiye's tourism-driven environmental impact from 1995 to 2017 by including both variables. Two different models were used for EF and $CO_2$ emissions. These models integrated variables such as tourist inflow, GDP per capita and energy consumption. Both models unveiled compelling evidence attributing tourism development to environmental degradation, prompting further exploration into the specific ecological impacts attributed to tourism-related activities.

## 3. Data and Model

The research delves into the dynamic interconnections between the environment and the progression of tourism, economic growth, green innovation, and government effectiveness between 2000-2018 while assessing their alignment with the EMT. The selection of nations for data analysis is predicated on the World Tourism Organization's European Region, encompassing Austria, France, Greece, Germany, the United Kingdom, Spain, Italy, Türkiye, Poland, and Russia. These countries collectively constitute over 50% of global tourist arrivals and approximately 30% of worldwide tourism receipts (UNWTO, 2020). Fuelled by their rich historical, cultural, and natural assets, these nations hold a strong global competitive edge. Moreover, locales such as Italy, Spain, and France have witnessed local populations voicing concerns about the adverse impacts of intensive tourist mobility on the environment (Milano et al., 2018: 3-4; Çam & Çelik, 2022: 75-76; Turizm Gazetesi, 21.06.2023). As tourism may continue to pose an environmental threat and tourist mobility is predicted to increase, the ten European countries receiving the most tourists in 2019 were appropriately selected as the analytical sample. The availability of the necessary data was considered when determining the working time. In defining the variables, care was taken to reflect the essence of EMT and to be consistent with the empirical examples found in the current literature. A comprehensive breakdown of the variables used in the study is presented below.

The EF, chosen as the dependent variable in our model, quantifies the intricate balance between nature's provision and human demand. The EF methodology adopts a systemic approach towards natural resource accounting, operating across global, regional, local, and personal scales of supply and demand (Wackernagel & Rees, 1998). This method offers a holistic perspective on natural resources, facilitating the evaluation of an ecosystem's biocapacity to endure human consumption of biological assets and the ensuing waste production. Calculated in terms of biomass areas produced through photosynthetic energy utilisation, the EF for a population embodies the utilisation and consumption dynamics (Kitzes et al., 2009). Lately, EF has garnered recognition as a more encompassing gauge for encapsulating environmental dimensions (Chu, 2022: 23781).

The tourist flows act as an embodiment of tourism demand and visitor inclinations. Over time, an upswing in tourist numbers directly corresponds to escalated requisites for services, transportation, lodging, sustenance, shopping, and other tourist activities within a country. Consequently, the augmentation in tourist figures, while contributing to economic aspects, concurrently manifests as an indicator of straining the carrying capacity of host destinations and encroaching upon the environment (Solarin, 2014; Vita et al., 2015; Katırcıoğlu et al., 2018). This study harnessed the count of international tourists as a metric to gauge the tourism sector's scale and impact.

Gross domestic product per capita emerges as a representation of economic prosperity. Elevated levels of economic activity inevitably engender augmented energy and material requisites, yielding heightened waste byproducts. The depletion of natural resources, combined with the accumulation of waste and the concentration of pollutants, can exceed the Earth's carrying capacity, leading to an erosion of environmental quality and a decline in human well-being despite rising incomes (Xepapadeas, 2005:1254). The nexus between environmental deterioration and elevated resource consumption is well-established, with a discernible correlation between heightened fossil fuel utilisation for energy and economic growth detrimentally impacting the environment (Ahmad et al., 2021).

Environmental technology patents were embraced as a representative indicator of green innovation. These patents confer a competitive edge upon patent holders, fostering environmental sustainability through their contributions to the burgeoning green economy (Sun et al., 2007: 1033). This metric is gauged through the number of licensed environmental patent applications, encompassing domains like renewable energy technologies, energy efficiency enhancements, waste management, recycling, clean water technologies, green construction, and materials. This dataset essentially mirrors the tally of environmental technologies originating from a company or nation, thus signifying a robust indicator capturing the degree and intensity of green technological innovation, both utilised and owned (Oyebanji et al., 2022: 8; Kirikkaleli et al., 2023: 101564). Within this study, green innovation patents are posited to conduce to a reduction in the EF.

The efficacy of government policies is found in the dataset on government effectiveness. This parameter epitomises how a government efficiently crafts policies, legislates, delivers public services, and caters to citizens' requirements. Government effectiveness is a barometer for a government's adeptness in addressing societal needs, securing public trust, and orchestrating prudent policies conducive to sustainable development (Yasmeen et al., 2022; Al Mulali, 2022).

**Table: 1**
**Source of Data**

| **Variables** | **Symbol** | **Unit** | **Source** |
|---|---|---|---|
| Ecologic Footprint | EF | Global Hectare | Global footprint network (<www.footprintnetwork.org/>) |
| Tourist Arrival | TA | Number | Word Bank(<www.data.worldbank.org/>) |
| GDP per Capita (Constant 2015) | EG | US$ | Word Bank (<www.data.worldbank.org/>) |
| Environmental Technology Patents | GI | Number | OECD (<www.data.oecd.org/>) |
| Government Effectiveness | GE | Value | Word Bank (<www.data.worldbank.org/>) |

The model, formulated in a logarithmic configuration as delineated in Equation (1), aims to embody the EMT by drawing on the research of Koçak et al. (2020), Alola et al. (2021), Nathaniel et al. (2021), and Bugden (2022).

$$\ln EF_{it} = \alpha_i + \beta_1 (lnTA_{it}) + \beta_2 (lnEG_{it}) + \beta_3 (lnGI_{it}) + \beta_4 (lnGE_{it}) + \varepsilon_{it} \quad (1)$$

In Equation (1), α signifies the constant coefficient, while β1, β2, β3, and β4 represent the coefficients corresponding to the number of tourists, gross domestic product per capita, environmental technology patents, and government efficiency parameters, respectively. The term ε denotes the error component. Herein, i and t represent the dimensions of country and time, respectively.

The descriptive statistics have been delineated in Table 2.

**Table: 2**
**Data Statistics**

| Variables | Observation | Minimum | Maximum | Mean | Std. Dev. |
|---|---|---|---|---|---|
| EF | 190 | 1,25 | 3,90 | 2,91 | 0,50 |
| TA (million person) | 190 | 10,42 | 89,40 | 63,26 | 56,39 |
| EG | 190 | 5324 | 47492 | 26608 | 13389.70 |
| GI | 190 | 4.80 | 19.24 | 10.95 | 3.01 |
| GE | 190 | -0.67 | 1.93 | 0.90 | 0.71 |

## 4. Methodology

The dynamic panel data analysis employed to explore the environmental impact of tourism uses the AMG coefficient estimator. After conducting crucial preliminary assessments encompassing cross-sectional dependence and homogeneity, this section expounds upon the AMG coefficient estimator, a prerequisite for accurate coefficient estimation.

The countries chosen for empirical scrutiny constitute members of the European Union, sharing common economic, social, and environmental policies, except for Russia and Türkiye. Owing to the interdependence among these nations, shared shocks and latent common factors within the panel data configuration may potentially engender unreliable and inconsistent estimations. Consequently, while determining the appropriate tests for analysis, it becomes imperative to ascertain the existence of cross-sectional dependence. This study's temporal dimension (21) surpasses the cross-sectional dimension (10). As a result, for scenarios of this nature, it is advisable to employ the Breusch-Pagan (1980) LM and Pesaran (2004) CD tests, as recommended by Koçak & Uçak (2021). Within this study, the outcomes of the Breusch Pagan (1980) LM and Pesaran (2004) CD tests have been considered in evaluating cross-sectional dependence.

The Breusch-Pagan (1980) LM test scrutinises the null hypothesis, positing an absence of correlation among units. The equation expressing this hypothesis is presented in equation (2), wherein the parameters i and j denote the correlation coefficient between the coefficients of the respective units.

$$LM = T\Sigma_{i=1}^{N-1}\Sigma_{j=i+1}^{N}\hat{\rho}_{ij}^{2} \quad (2)$$

Pesaran's (2004) CD test operates on summating correlation coefficients among the cross-sectional residuals. Equation (3) delineates the formulation of this test.

$$CD = \sqrt{\frac{2T}{N(N-1)}} \Sigma_{i=j}^{N-1} \Sigma_{j=i+1}^{N} \hat{\rho}_{ij} \quad (3)$$

Another preliminary test is to examine whether the slope coefficients are homogeneous. Breitung (2005) argues that slope heterogeneity is critical in selecting appropriate model estimators and can lead to incorrect inferences. This test guides the choice of cointegration test. The Delta (△) tests, devised by Pesaran &Yamagata (2008), assess the presence of homogeneity in the coefficients. The formulated hypotheses are as follows:

$$\tilde{\Delta} = \sqrt{N} \left( \frac{N^{-1}\tilde{S} - k}{\sqrt{2k}} \right) \quad (4)$$

Within Equation (4), the symbol "N" represents the count of cross sections, "$\tilde{S}$" signifies the adjusted Swamy test statistic, and "k" denotes the count of explanatory variables.

$$\tilde{\Delta}_{adj} = \sqrt{N} \left( \frac{N^{-1}\tilde{S}E(\tilde{z}_{it})}{\sqrt{var(\tilde{z}_{it})}} \right) \quad (5)$$

In Equation (5), E($\tilde{z}_{it}$) = k ve $var(\tilde{z}_{it}) = \frac{2k(T-k-1)}{(T+1)}$ where , “ $\tilde{z}_{it}$” denotes random variables independently distributed across all “i” with finite means and variances (Pesaran & Yamagata, 2008: 32).

The AMG estimator in dynamic panel data analysis possesses several advantageous characteristics. Notably, it circumvents the need for variables to exhibit stationarity levels within the analysis. This implies that the presence of differing levels of stationarity across variables does not hinder the application of the AMG method. Additionally, this estimator effectively accounts for cross-sectional dependence within the series (Yerdelen-Tatoğlu, 2018). Another merit of the AMG method lies in its capacity to rectify outcomes amidst panel heterogeneity and multifactor error terms. Despite its origination as a long-run cointegration estimator tailored for a limited number of units and periods, the AMG estimator produces resilient results (Uzar, 2021: 389). Consequently, the prerequisite for conducting preliminary tests, such as unit root and cointegration tests, is obviated (Cheng & Yao; 2021: 5). Moreover, by enabling separate estimation of country coefficient estimates through the AMG method, distinct policy recommendations for individual countries can be formulated. Collectively, these attributes hold substantial implications for estimation and inference within the realm of macro panel data (Eberhardt & Bond, 2009; Eberhardt, 2012).

The AMG coefficient estimator, notable for incorporating a 'common dynamic effect' into group-specific regressions to account for cross-sectional dependence, is constructed from the period dummy coefficients of a pooled regression in first differences. This construction captures the average path of unobserved common factors across panel groups, similar to their levels. The augmented regression model captures this relationship well in cases where these unobserved common factors are elements of the group-specific cointegration relationship. (Eberhardt & Bond, 2013: 2). The hypotheses for the two-stage are as follows:

$H_0$: Coefficients are not significant.

$H_1$: Coefficients are significant.

In the first stage, a standard POLS regression is constructed with variables in the first difference by including first-stage dummy variables in the model, as shown in equation (6). Since non-stationary variables and unobservable can seriously bias the estimates in first-difference regressions, the dynamic process is excluded from the first-difference pooled regression. The coefficient of the time dummy variable represented by "$\tilde{u}_t^{\bullet}$" is estimated.

$$\Delta y_{it} = b'\Delta X_{it} + \Sigma_{t=2}^{T} C_t \Delta D_t + e_{it} \implies \tilde{c}_t \equiv \tilde{u}_t^{\bullet} \quad (6)$$

In the second stage, as presented in equation (7), the variable " $\tilde{u}_t^{\bullet}$" is constructed by including it in each group-specific regressions that comprise the cross-sectional unit. These include linear trend terms, which do not capture idiosyncratic processes that disappear linearly over time. The AMG estimates are obtained as the average of the individual β̂i (individual country) estimates following the Mean Group approach of Pesaran and Smith (1995).

$$y_{it} = +a_i + b'\Delta X_{it} + c_{it} + d_i \tilde{u}_t^{\bullet} + e_{it} \implies \hat{b}_{AMG} = N^{-1} \Sigma \hat{b}_i \quad (7)$$

## 5. Findings and Discussion

This section presents cross-section dependency and homogeneity tests and their results. Then, the AMG coefficient estimation analysis findings are given, in which the long-term coefficients are calculated for the panel as a whole and each country. Firstly, the investigation involved the application of the Breusch-Pagan (1980) and Pesaran (2004) cross-section dependence tests to the variables to describe the possible presence of horizontal cross-sectional dependence. The test results show that the null hypothesis is rejected at the 1% significance level, leading to the conclusion of cross-sectional dependence. This evidence of cross-section dependence implies that disturbances or crises within countries in the panel data could impact other countries in the same panel. Based on the outcomes of the homogeneity test, the null hypothesis is rejected, indicating the absence of homogeneity in the panel data slope coefficient. Proceeding from these preliminary assessments, the investigation delved into the long-run coefficients underpinning the relationships within Equation (1), utilising the AMG estimator.

**Table: 3**
**Test Findings**

| Tests | Cross-Sectional Dependence Test | | | | |
|---|---|---|---|---|---|
| | lnEF | lnTG | lnEG | lnGI | LnGE |

| | | | | | |
|---|---|---|---|---|---|
| LM (Breusch-Pagan, 1980) | 152.6451*** (0.002) | 207.8493*** (0.000) | 289.7389*** (0.000) | 226.5631*** (0.001) | 173.7688*** (0.000) |
| $CD_{LM}$ (Pesaran, 2004) | 21.6235*** (0.000) | 35.782*** (0.000) | 43.4529*** (0.000) | 39.7641*** (0.003) | 26.4472*** (0.000) |
| | **Homogeneity Test** | | | | |
| | | LM Statistic | | | |
| Delta _tilde ($\tilde{\Delta}$) | | 11.538*** (0.000) | | | |
| Delta_tilde_adj( $\tilde{\Delta}_{adj}$) | | 13.892*** (0.000) | | | |

*Notes: Probability (p) values are given in parentheses, and the “***” symbol denotes a 1% significance level.*

According to the AMG-derived long-run coefficient estimations in Table 4, tourism development and economic growth exhibit statistically significant positive environmental impacts. In contrast, green innovation and government efficiency display statistically significant negative environmental influences.

**Table: 4**
**Results for AMG Coefficient Estimators**

| Countries | Variables | | | |
|---|---|---|---|---|
| | lnTD | lnEG | lnGI | lnGE |
| Panel | 0,71*** | 1,39*** | -0,45* | -0,37** |
| Germany | -0,24** | 0,09*** | -1,86*** | -2,93** |
| Austria | 0,18** | 0,12*** | 0,52 | -0,28 |
| France | 1,97*** | 0,23*** | -2,32** | 1,57** |
| United Kingdom | 0,11*** | 0,07** | -0,89*** | -1,83** |
| Spain | 1,41*** | 1,26*** | 0,04 | -0,12*** |
| Italy | 2,86*** | 2,13*** | -0,95** | 0,05 |
| Poland | 0,13 | 3,25* | 0,65 | -0,28 |
| Türkiye | 0,67*** | 2,76** | -0,71 | 1,01 |
| Greece | 0,16** | 2,43*** | 1,04 | 0,62** |
| Russia | 0,21*** | 1,63*** | -0,08* | -1,51*** |

*Note: *, ** and *** signify statistical significance at 10%, 5% and 1%, respectively.*

Specifically, a 1% escalation in tourism development yields a 0.71% rise in the EF, while a similar uptick in economic growth is associated with a 1.39% augmentation in the EF. Conversely, a 1% increase in green innovation corresponds to a 0.45% reduction in the EF, and a 1% improvement in government efficiency leads to a 0.37% decrease in the EF.

Conducting a granular examination via the AMG estimator's disaggregated (country-specific) analysis, the coefficient about tourism development emerges as statistically significant, exerting a positive impact on the EF in Austria, France, the United Kingdom, Spain, Italy, Türkiye, Greece, and Russia. Thus, it can be inferred that tourism in these nations contributes detrimentally to the environment. Conversely, the influence of tourism development in Germany manifests negatively, suggesting a positive environmental effect. Notably, the coefficient for Poland does not reach statistical significance.

The coefficient associated with the economic growth variable is statistically significant across all countries within the panel and positively influences the EF. In essence, economic growth emerges as one of the contributing factors to environmental degradation across the entire panel of countries.

The coefficient of the green innovation variable is statistically significant and negatively impacts the EF in Germany, France, the United Kingdom, Italy, and Russia.

Notably, an upswing in the number of environmental technology patents correlates with a positive effect on the environment within these nations. However, the coefficients in Austria, Spain, Poland, Türkiye, and Greece lack statistical significance.

The variable of government effectiveness yields a statistically significant coefficient in Germany, France, the UK, Spain, Greece, and Russia, signifying a negative impact on the ecological footprint. This implies that successful governmental practices contribute positively to the environment within these countries. However, the coefficient for this variable fails to attain statistical significance in France, Italy, Poland, and Türkiye.

Specifically, in Austria, France, the United Kingdom, Spain, Italy, Türkiye, Greece, and Russia, tourism contributes to an increase in EF, while Germany experiences a decrease in EF due to tourism activities. This finding resonates with Öztürk et al. (2016), Katırcıoğlu (2018), Kongbuamai et al. (2020), Karadağ (2021), Alola et al. (2021), Kutlu & Kutlu (2022), and İlban & Liceli (2022), although diverging from the observations of Guan et al. (2022). Meanwhile, economic growth drives an expansion in the EF across all countries, a pattern reminiscent of Charfeddine & Mrabe (2017), Hassan et al. (2019), and Çakmak & Acar (2022). Furthermore, promoting green innovation reduces the ecological footprint across the panel and within Germany, France, the UK, Italy, and Russia. These outcomes align with the research shared with Ahmad et al. (2021), Javed et al. (2023), and Aydın et al. (2023). Lastly, government effectiveness, symbolising the state's role, contributes to a decrease in EF across the entire panel, specifically within Germany, France, the United Kingdom, Spain, Greece, and Russia. These results are akin to Uzar et al. (2021), in contrast to Yang et al. (2022).

The economic implications of the results obtained are presented below, as appropriate.

The results for the whole panel show that the environmental impact of tourism is lower than that of economic growth. This finding suggests that the negative environmental impacts of tourism development are more accessible to control than economic growth. A 1% increase in economic growth is associated with a 1.39% increase in EF, reflecting the footprint-increasing effect of economic growth. Higher income levels can lead to increased consumption and production, leading to increased depletion of natural resources and environmental impacts. A 1% increase in green innovation corresponds to a 0.45% decrease in EF, indicating that green technologies and environmentally friendly practices can potentially reduce environmental impacts. Green innovation can achieve a positive balance between economic growth and environmental impacts by increasing environmental sustainability. A 1% improvement in government efficiency leads to a 0.37% decrease in EF, indicating that more effective government policies positively impact environmental sustainability. More effective government policies can ensure more effective conservation of natural resources and reduction of environmental impacts.

## 6. Conclusion and Recommendations

This study examines the influence of tourism on the environment across ten distinct European destinations, which attract more than half of international tourists, spanning the period from 2000 to 2018. The central aim is to discern whether the development of tourism supports EMT. A dynamic panel data model is meticulously constructed to address this, incorporating the environment (measured by EF) as the dependent variable. The explanatory variables encompass tourism (quantified by tourist count), economic advancement (represented by gross domestic product per capita), green innovation (indicated by environmental technology patents), and government efficiency (reflecting state intervention efficacy). As a result of the preliminary tests, it was concluded that there is a cross-section dependence and heterogeneity among the panel countries. Subsequently, the AMG long-run coefficient estimator is tested, and panel-wide and country-specific coefficients are estimated. Empirical outcomes support the EMT within the entire panel, Germany, France, the United Kingdom, and Russia. Conversely, coefficients associated with green innovation and/or government effectiveness do not hold statistical significance in Austria, Spain, Italy, Poland, Türkiye, and Greece, signalling a lack of support for the EMT theory. Consequently, it can be inferred that the conjunction of tourism and economic growth poses a substantial menace to environmental deterioration, whereas the impetus of green innovation and effective governmental policy execution safeguards environmental sustainability.

In light of the findings, policymakers and managers may wish to consider the following recommendations:

- These panel countries need a lot of energy to sustain economic growth. Therefore, the first recommendation is to promote the implementation of green growth, green economy models, and policies on renewable energy and green technologies in all panel countries. Political, economic, and technical cooperation among panel countries to develop and share practices can help reduce negative environmental externalities.
- Secondly, it is suggested that the development of cooperation and implementation processes such as sustainable tourism, green tourism, eco-tourism, and slow tourism, which are on the World Tourism Organization's agenda in the Panel countries, should be identified as a priority policy area. Keeping environmental awareness on the agenda of all tourism stakeholders through bilateral or multilateral agreements, projects, campaigns, and training also contributes to protecting the environment.
- Thirdly, it is suggested that examples of good practices in tourism (benchmarking) and successful policy outcomes should be shared among the panel countries through meetings, symposiums, and congresses. For example, the discussion of the impact of the reservation system, the limitation of the number of daily visits, the entry/exit during certain hours, the environmental tax, the environmental subsidy practices in some tourist areas for the protection of the natural environment can contribute to the creation of strategies to improve the

environmental quality in the panel countries. In addition, creating virtual visit options (VR- virtual reality glasses, AR - augmented reality applications) at a lower cost for tourists who want to benefit from the output of digital technology can reduce the pressure of destruction on the environment.

- The fourth suggestion relates to what policymakers can do for tourism businesses. It suggests encouraging the use of renewable energy and environmentally friendly materials in tourism facilities and businesses, carrying out full waste management audits, supporting green hotels, green kitchens, green tour operators, green transport practices, and green innovation research in tourism businesses through subsidies.

Among the country-specific findings, the following recommendations can be considered:

- In Austria, France, the UK, Spain, Italy, Türkiye, and Greece, sustainable tourism policies should be developed to reduce the impact of environmental degradation, encourage the active participation of local communities, and support investments in environmentally friendly infrastructure and technology. Considering that tourism in Germany positively impacts the environment, it is recommended that environmentally friendly tourism practices be shared at global meetings.
- According to the study's results, due to the positive effects of the GI variable in Germany, France, the United Kingdom, Italy, and Russia, technical agreements on patent sharing on a global basis are recommended to stimulate environmental technology patents in these countries. Appropriate policies and strategies should be determined according to each country's specific conditions and needs. However, promoting green innovation and adopting green technologies will enhance environmental sustainability.
- Given that government effectiveness plays a vital role in reducing environmental impacts in Germany, France, the United Kingdom, Spain, Greece and Russia, environmentally friendly policies should be strengthened, and more comprehensive policies should be adopted. Active public participation and support can increase the success of environmental policies.

This research is on the environment and tourism nexus by including tourism in the EMT with available data from ten selected destinations in the European Region. This is the weakness of the study. For this reason, the theoretical evidence obtained in the study needs to be developed with research objects that include developing countries. Testing this theory with more countries or individual countries with a more extended range of data would be helpful to obtain comparable results. In future studies, investigating the impact of tourism on the environment with more specific pollution indicators (water, air, noise, soil, etc.) and new variables such as tourism income and tourism development index may help to keep the debate on the issue on the agenda and to develop policy recommendations.

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