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RESEARCH ARTICLE

Perspectives of globalization and tourism as drivers of ecological footprint in top 10 destination economies

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Abstract
Beyond the anticipated experience associated with tourism destinations, the United Nations World Tourism Organization (UNWTO) has further tasked (especially the destination countries) on the importance of tourism to achieving the 2030 Sustainable Development Goals (SDGs). From this dimension, this study employed the ecological footprint of the 10 most visited countries (France, Spain, United States, China, Italy, Mexico, United Kingdom, Turkey, Germany, and Thailand) over the period 1995–2016. Specifically, the study employed an econometric approach and found that increase in tourism arrivals and globalization is detrimental to the attainment of sustainable environmental quality in a long term. Precisely, a 1% increase in international arrivals and globalization is responsible for a 0.18 and 0.89% increase in ecological footprint in the long-run. These impacts of tourism activities and globalization are detrimental to the environmental quality of the destination countries. Meanwhile, the real income per capita and biocapacity in the destination countries improve the environmental quality of the panel of destination countries in the long-run. In addition, the study found significant evidence of Granger causality from tourism and real income to ecological footprint without feedback, the globalization-ecological footprint Granger causality nexus is with feedback. Moreover, potentially effective policies for government and other stakeholders especially toward attaining Global goals were proffered in the study.

Keywords SDGs · Environmental quality · Globalization · Tourism · Destination countries

Introduction

Humanity has been faced with the challenges and responsibilities of maintaining a decent lifestyle amidst the burden of ever-increasing dynamics of the ecologically targeted activities. Daily, people globally depend on the uninterrupted interactions with the Earth's natural life as the source of human supplies and support systems (Organization for Economic Co-operation and Development [OECD] 2017). Keeping the Earth's natural-life support systems in the balance is perhaps the overarching goal of many organizations such as the United Nations Environmental Programme (UNEP) and the United Nations Framework Convention on Climate Change (UNFCCC). However, the insatiable nature of human needs always means that achieving that balance is almost impossible.

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The global concern for attaining a sustainable environment is increasing. In its recent release of the Global Environmental Outlook (GEO 6), UNEP summarized the concern as follows:

> "Climate change is a priority issue affecting both human systems, including human health, and natural systems—air, biological diversity, freshwater, oceans and land—and which alters the complex interactions between those systems (well established). Historical and ongoing greenhouse gas emissions have committed the world to an extended period of climate change (well established), which is leading to global warming of air and ocean; rising sea-levels; melting glaciers, permafrost, and Arctic sea ice; changes in carbon, biogeochemical and global water cycles; food security crises; freshwater scarcity; and more frequent and extreme weather events. Higher atmospheric concentrations of carbon dioxide also lead to ocean acidification and affect the composition, structure, and functionality of ecosystems. Time is running out to prevent the irreversible and dangerous impacts of climate change. Unless greenhouse gas emissions are radically reduced, the world is on course to exceed the temperature threshold set out in the Paris Agreement under the United Nations Framework Convention on Climate Change. That makes climate change a global driver of environmental, social, health, and economic impact and heightened society-wide risks. {2.7.3}" (UNEP 2019 p. 6–7).

The current trend has continued to reveal that the rapid hazardous decline in environmental quality amidst the global climatic change is one of man persistent challenges of the 21st century (Alola 2019a, b; Alola et al. 2019a, b). Lamentably, environmental degradation is the byproduct of human development which is inevitable for survival and sustenance (Hassan et al. 2019a, b; Ulucak and Khan 2020; Wang et al. 2020). For instance, many scholars have documented the impact of globalization on economic development (Saint Akadiri et al. 2019; Akadiri et al. 2020b; Saint Akadiri et al. 2019a, b, c, d; Akadiri et al. 2020c). Other scholars also documented the causal effect of economic development and related factors on environmental degradation (Alola 2019b; Bekun et al. 2019a, b; Adedoyin et al. 2020). Thus, human-induced pressure contributes greatly to the imbalance of the Earth's natural life support system that is essential for maintaining the sustainability of the environment.

Furthermore, tourism as a key contributor to economic growth and globalization directly and/or indirectly impacts environmental degradation (Saint Akadiri et al. 2019a, b). When tourism grows, it births infrastructural developments in the forms of road construction, air and seaports, facilities, and other infrastructures. These infrastructural developments are projects that consist of specific environmental aspects. For instance, land claimed for airport or seaport development may indeed result in the destruction of wildlife or aqua-life decimation, reduced agricultural outputs, increased ocean and air temperature, and unpredictable amount of rainfall amongst others (Hassan et al. 2019a, b; Shahbaz et al. 2018a; Solarin et al. 2017; Zhang et al. 2018).

Leaning on the above-illustrated motivation of environmental sustainability mainly within the context of tourism development and globalization, the current study objectively advances the perspective, especially for destination countries. While the economic contribution of globalization and tourism development cannot be overstated, their impact on environmental degradation also cannot be overlooked. On this note, this study takes ditto from the conventional approach and employed a more comprehensive indicator of an ecological footprint as a proxy for environmental degradation to examine the impact of tourism activities, globalization, and real income in the panel of first 10 tourist destination countries over the period 1995–2016. Although previous studies have partially investigated related environmental conditions (Katircioglu et al. 2018; Destek and Sarkodie 2019), the current study is designed to significantly contribute to the extant literature uniquely. Notably, the current study examines the environmental sustainability of the world's top 10 destination countries (France, Spain, United States, China, Italy, Mexico, United Kingdom, Turkey, Germany, and Thailand) as named by the United Nations World Tourism Organization (UNWTO 2018). Also, ecological footprint (EFP) is employed in lieu of the conventional carbon emission or the Greenhouse gas (GHG) to account for the environmental quality of the destination countries.

Moreover, while the study of Katircioglu et al. (2018) fell short of providing dynamic relationships in related studies, the current present the long-run and short-run cross-sectional relationships.

The other sections are presented as follows. An overview of environmental quality is presented in section 2. Materials and methods are illustrated in section 3 while the results are discussed in section 4. Section 5 offers the conclusion with policy implications and recommendations for future study.

Overview of environmental quality

Although extant literature has extensively focused on the contribution of economic growth, globalization, tourism, and more human-induced pressure on environmental degradation, most of those studies have rather investigated the causal effects through a more myopic indicator of carbon dioxide emission (Akadiri et al. 2019; Alola et al. 2021; Asumadu-Sarkodie and Owusu 2017; Bekun et al. 2019a; Sarkodie 2018; Shahbaz et al. 2018a, b; Uzuner et al. 2020). While carbon emission is a valid indicator of pollution and degradation, it is a monotonous indicator that is concerned with just an aspect of the environment. This approach is seen as the consumption-based approach thereby making it almost impossible to understand the dynamics of environmental pressure since the biocapacity is neglected (Destek and Sarkodie 2019; Saint Akadiri et al. 2019b).

Contrarily, the EFP according to Wang, Yang, Yin, and Zhang et al. (2018) is an all-inclusive indicator for assessing the human behavior created eco-environmental pressure (Luo et al. 2018; Akadiri et al. 2020a; Eluwole et al. 2020). The EFP considers in totality the area of biomass productive land which is required to generate resources for a given population and to enthrall the resulting waste generated by this population (Wackernagel and Rees 1996; Rees and Wackernagel 2008). The EFP model measures sustainable development or sustainability by converting the human resource consumption and their associated environmental pollution, into the needed ecologically fecund land area and compares with the actual ecologically productive land area required for optimal resource utilization (Luo et al. 2018).

By using the EFP to proxy for environmental degradation, Destek et al. (2018) found that in EU countries where it is believed to have and implement most extensive environmental laws, non-renewable energy increases environmental degradation while renewable energy and trade openness decreases the environmental degradation. A similar finding on Pakistan presents that bidirectional causality exists between natural resources and the ecological footprint. This relationship is in addition to the evidence of long-run causality between biocapacity and the ecological footprint (Hassan et al. 2019b). In a robust study of 128 developing countries, Solarin and Bello (2018) found that EFP is not stationary in 96 of the countries investigated. Their finding implied that the tendency of EFP to travel at a trended path exists especially in an upward trajectory without relapsing for a period in time. In a simpler form, it implies that these countries exert continuous excessive pressure on their EF than their regenerative biocapacity thereby resulting in a state of ecological deficit.

Recently, results of globalization-environment nexus studies revealed a rather conflicting effect of globalization on the environment. For instance, Sharif et al. (2019) found a bidirectional positive effect on some globalized states while they reported negative effects in the case of France, Hungary, Germany, and the UK. While they reported a significant difference between the effect of globalization on environmental degradation for OECD and non-OECD countries, Bu et al. (2016) concluded that globalization actively predicts environmental degradation. In addition, Usman et al. (2020) considered the case of the USA in examining the role of globalization and renewable energy in the ecological footprint of the country. Specifically, the result of the study implies that globalization exerts a positive effect on the country's ecological footprint both in the short- and long-run terms. Whereas, Saint Akadiri et al. (2020a) and Saint Akadiri et al. (2020b) respectively found that globalization mitigates carbon emission in both the short- and long-run for the case of China and that globalization does not affect carbon emission in Turkey.

Another strand of scholarly literature has focused on the impact of the tourism-induced growth hypothesis. This research area attributes the economic growth experienced in certain economies to their positive attitudes towards tourism development (Antonakakis et al. 2019; Danish and Wang 2018; Fareed et al. 2018; Lasisi et al. 2020; Saint Akadiri et al. 2019a; Saint Akadiri et al. 2020). Like globalization, tourism development inevitably contributes to environmental degradation. The high infrastructural requirement for tourism development implies that the natural resources which are essential to keep the earth's life support in the balance are exploited to attract tourism growth (Katircioglu et al. 2018). Unwanted environmental impact of tourism development becomes inevitable given that actions like deforestation, freshwater waste, and overuse of raw materials which are detrimental to the healthy living of the natural ecosystem are needed to realize the tourism development objectives (Alola et al. 2019a).

Although scholars are divergent in their view of the impact of tourism on environmental degradation as some claimed that tourism development imposes a negative effect on the environment (Katircioglu 2014; Tang et al. 2014), and others assert that development in tourism infrastructures decreases the pollution of the environment (Lee and Brahmasrene 2013). Even more, a vibrant move in literature believed that the environmental Kuznets curve hypothesis holds true in the case of tourism's impact on environmental sustainability. This stream of researchers empirical proved that tourism development negatively impacts the environment only at its inception through development to maturity stage after which there will be e reverse effect on the environment (Azam et al. 2018; Katircioglu et al. 2018; Saint Akadiri et al. 2019).

Materials and method

Materials and variables description

The main materials employed for this investigation are accounted for by the National Footprint Accounts (NFA). In this case, the ecological footprint and the biological capacity (biocapacity) are utilized because of their potential relationship with human activities, climate, and resource management within the ecosystems. Importantly, the sustainability of the forestry land, cropland, fishery, grazing land, and carbon footprint components of the ecosystem is key to achieving the humans' and environmentally sustainable development plans. In addition, the income level, which implies the real economic growth measured in United States Dollars (USD) in constant

2010, the activity of the tourism sectors as measured by the international tourism arrivals, and globalization are all consequential to human activities. Hence, measuring environmental degradation over the period 1995–2016 by employing the ecological footprint is posed to address and provide more specifics environmental information toward the attainment of sustainable development targets. Importantly, the environmental quality of the panel of France, Spain, United States, China, Italy, Mexico, United Kingdom, Turkey, Germany, and Thailand is considered by employing the aforementioned materials. The data, unit of measurement and sources employed are further illustrated in detail in Table 1. In addition, the common statistical properties of the datasets are provided in Table 2.

Methods

This study employs the variables of interest (*efp*, *arrival*, *biocap, gdp*, *and global*) to importantly investigate the environmental sustainability of the major global destination countries. By adopting the previous econometric approaches of Destek and Sarkodie (2019) and Katircioglu et al. (2018), it suffices that ecological footprint could significantly be employed to model the environmental sustainability of the destination countries in the context of tourism, globalization, real income, and importantly the biological capacity. This implies that

$$efp = f|arrival, global, gdp, biocap| \quad (1)$$

such that the logarithmic expression (denoted by l) of the econometric model (1) becomes

$$lefp_{i,t} = \partial_0 + \partial_1 larrival_{i,t} + \partial_2 \mathrm{l}global_{i,\mathrm{t}} + \partial_3 \mathrm{l}gdp_{i,\mathrm{t}} + \partial_4 lbiocap_{i,t} + \varepsilon_{i,t} \quad (2)$$

where i = 1, 2, 3, …, 10 is the cross-sections (i.e., 1 = France, 2 = Spain, 3 = United States, 4 = China, 5 = Italy, 6 = Mexico, 7 = United Kingdom, 8 = Turkey, 9 = Germany, and 9 = Thailand) and t = 1, 2, …, T is the time period 1 = 1995, 2 = 1996, …, T = 2016. Also, the$\varepsilon_{i,\ t}$ is the corresponding error term for each i and t such that ε normally distributed with constant variance.

Unit root and cointegration tests

Before proceeding to investigate the cointegration evidence and other relationship between the variables, it is important to examine the stationarity of the variables to ensure that each of the variables in the panel does not fluctuate away from a constant mean. This is important to avoid unreliable results that could posit misleading information. Hence, three empirical tests that evaluate the unit root of the variable of interest are employed in the current study. These panel unit root estimation methods are Levin et al. (2002), Im et al.'s (2003), and the Fisher-ADF by Maddala and Wu (1999). For brevity, the details and step-by-step procedures of the unit root test are not provided. In Table 3 below, the result of the panel unit root estimations for the investigated variables is presented. Indicatively, the results informed that all variables are non-stationary especially when having a trend property but stationary at the first difference (integrated of order 1).

Cointegration test

This section is designed to investigate if the variables of interest have similar properties across the sections and over the indicated period. For instance, the cointegration evidence could reveal if the ecological footprint and the number of tourist arrivals over a period of time in the panel countries increases exhibit similar properties (such increase or decrease). Hence, since the variables are all integrated of order one, i.e., I (1), we employ the Kao panel cointegration test proposed by Kao (1999) because of its similarity and robustness superiority to the Pedroni approach. Given the result of the Kao panel cointegration test (the procedure is not provided for brevity), as shown at the bottom of Table 3, the null hypothesis of no cointegration is rejected at the 5% significance level. Hence, it implies that there is a long-run relationship between the efp, arrival, global, gdp, and the biocap across the panel of top 10 tourists' destination countries investigated and over the indicated period.

Table 1: Data description and measurement units

Variable name	Symbol	Unit of measurement	Source
Ecological footprint	EFP	Global hectare of land per capita	GFN
Biocapacity	Biocap		GFN
International tourism arrivals	Arrival	Number of visiting tourists	WDI
Globalization	Global	Economic, social & political index	KOF
Gross domestic product per capita	GDP	Constant 2010 in $ USD	WDI

Note: The GN, WDI, and $ USD are respectively the Global Footprint Network (2019), World Bank Development indicator of the World Bank (2019), and the United States Dollars. Also, the KOF globalization index is the source for globalization and has been recently improved by Dreher et al. (2008) and Gygli et al. (2018).

Table 2: Descriptive statistics of the variables

C	Var.	Mean	Meadian	Min.	Max.	SD	Skewness	Kurtosis	Jarque-Bera
France	efp	2.959	2.968	2.729	3.236	0.146	0.094	2.128	0.729
	arrival	76113864	76113864	60033000	84452000	6570291	-0.979	3.404	3.659
	global	84.635	85.102	79.357	87.614	2.398	-0.920	2.897	3.110
	gdp	2.49E+12	2.57E+12	2.03E+12	2.81E+12	2.42E+12	-0.612	2.124	2.078
	biocap	1.72E+08	1.7#E+08	1.54E+08	1.81E+08	6453387	-0.840	3.664	2.99
Spain	efp	2.788	2.744	2.261	3.401	0.366	0.183	1.636	1.829
	arrival	52720091	52553500	32971000	75315000	10327292	-0.015	2.938	0.004
	global	81.392	82.208	74.829	85.304	3.010	-0.925	2.910	3.145
	gdp	1.28E+12	1.36E+12	9.41 + 11	1.48E+12	1.76E+11	-0.694		2.097
	biocap	63106452	64094519	47382727	70338942	5592833	-1.222	4.253	6.916**
United States	efp	5.319	5.392	4.892	5.839	0.301	0.132	1.723	1.584
	arrival	55437455	51107500	41218000	77774000	11417445	0.736	2.260	2.490
	global	79.406	79.758	75.013	82.096	1.989	-0.667	2.581	1.790
	gdp	1.40E+13	1.45E+13	1.03E+13	1.69E+13	1.92E+12	-0.376	2.128	1.215
	biocap	1.10E+09	1.10E+09	1.03E+08	1.17E+09	32633355	0.105	3.070	0.045
China	efp	1.548	1.510	0.953	2.225	0.500	0.179	1.435	2.364
	arrival	43109955	48361000	20034000	59270000	13781153	-0.365	1.537	2.364
	global	58.619	62.224	45.654	64.790	6.458	-0.829	2.205	3.098
	gdp	4.52E+12	3.80E+12	1.48E+12	9.51E+12	2.60E+12	0.531	1.929	2.084
	biocap	1.24E+09	1.23E+09	1.10E+09	1.37E+09	84305388	0.156	1.730	1.567
Italy	efp	2.942	2.942	2.602	3.320	0.229	0.118	1.775	1.427
	arrival	41365500	41119500	31052000	52372000	5781637	0.118	2.206	0.629
	global	79.817	80.630	73.837	82.5902	2.267	-1.305	4.037	7.229**
	gdp	2.07E+12	2.09E+12	1.87E+12	2.23E+12	8.87E+10	-0.491	2.664	0.988
	biocap	60092521	60396680	55549451	65645166	3347842	0.079	1.661	1.666
Mexico	efp	1.628	1.607	1.284	2.058	0.171	0.300	3.650	0.718
	arrival	22715409	21500500	18665000	35079000	4245832	1.736	5.216	15.552**
	global	63.474	63.917	56.089	72.118	4.795	-0.000	2.076	0.782
	gdp	9.93E+11	9.95E+11	7.07E+11	1.26E+12	1.49E+11	-0.049	2.271	0.496
	biocap	1.48E+08	1.48E+08	1.41E+08	1.50E+08	2195583	-1.132	4.137	5.885***
United Kingdom	efp	3.103	3.012	2.680	3.554	0.274	0.228	1.565	2.078
	arrival	27209091	28119000	20982000	35814000	4407693	0.253	1.892	1.361
	global	87.489		88.204	83.458	89.350	1.863	-1.149	2.893
	gdp	2.31E+12	2.40E+12	1.78E+12	2.76E+12	2.86E+11	-0.410	2.085	1.385
	biocap	75307298	75325963	70191565	78993640	2686983	-0.543	2.141	1.756
Turkey	efp	1.702	1.718	1.263	2.060	0.247	-0.025	1.658	1.654
	arrival 21711227	19594500	6893000	39811000	11920237	0.165	1.467	2.254	
	global	66.516	66.385	60.185	71.667	3.643	-0.136	1.596	1.875
	gdp	6.98E+11	6.82E+11	4.28E+11	1.12E+12	2.16E+11	0.586	2.123	1.966
	biocap	1.12E+08	1.13E+08	1.05E+08	1.18E+08	3402473	-0.335	2.291	0.873
Germany	efp	3.008	2.998	2.852	3.170	0.082	0.135	2.466	0.329
	arrival	23281273	22534500	14847000	35555000	6665861	0.469	1.945	1.826
	global	85.601	86.906	79.140	88.174	2.689	-1.252	3.271	5.816**
	gdp	3.29E+12	3.25E+12	2.84E+12	3.78E+12	2.77E+11	0.041	1.960	0.997
	biocap	1.38E+08	1.38E+08	1.30E+08	1.48E+08	4900722	0.176	2.329	0.526
Thailand	efp	1.295	1.329	0.975	1.630	0.193	-0.057	1.860	1.202
	arrival	15013864	12779500	6952000	32530000	7645571	0.982	2.802	3.574
	global	66.487	67.728	56.035	71.975	4.662	-0.770	2.638	2.293
	gdp	2.92E+11	2.91E+11	1.99E+11	4.07E+11	6.90E+10	0.184	1.643	1.813
	biocap	77129341	77761084	64018203	88141979	6820652	-0.324	2.253	0.895

Note: The C, Var, Min, Max, SD are respectively the country, Variable, Minimum, and Maximum. Also, EFP, arrival, global, gdp, and biocap are respective the Ecological Footprint, International tourist arrivals, the Gross Domestic Product per capita, globalization, and biocapacity. The notations ** and *** represent statistical significance at 5 and 10%. The number of observation for each variable is 22 (total number of observation is 220).

Long-run estimates

Given that the aforementioned stationary and cointegration tests are desirable, the investigation proceeds to the next stage of dynamic relationship investigation. Subsequently, the approach employed for this objective is designed to overcome the disadvantages of the ordinary least squares (OLS) estimators which include its asymptotically biasedness and nuisance parameters distribution characteristics and that are a probable cause of undesirable endogeneity and serial correlation (Nguyen and Kakinaka 2019). Hence, the superior potency of the Autoregressive Distributed lag (ARDL) to overcome the problem of endogeneity in addition to its capability of reporting both the short-run and the long-run parameter estimates in a single model is utilized for the current investigation. This is not to mention the merit of the ARDL approach is not being categorical of the order of integration of the series especially when none of the series is beyond *1(1)*.

Therefore, by employing the Pesaran and Smith (1995) which was further elaborated by Pesaran et al. (1999) approach, the lagged (p) dependent (*efp*) and lagged (q) explanatory (*arrival*, *global*, *gdp*, and *biocap*) variables are incorporated in the ARDL (p, q) of the below economic model:

$$lefp_{i,t} = \alpha_i + \sum_{j=1}^{p} \delta_{i,j} lefp_{i,t-j} + \sum_{j=0}^{q} \gamma_{i,j} Z_{i,t-j} + \varepsilon_{i.t} \quad (3)$$

such that the vector $Z_{i,\ t}$ (in Eq. 3) is a vector of the explanatory variables of interest, i.e.,$Z_{i,\ t}$ = (l*arrival*$_{i,\ t}$, l*global*$_{i,\ t}$, l*gdp*$_{i,\ t}$, l*biocap*$_{i,\ t}$). The α_i and $\delta_{i,\ j}$ are respectively the country-level fixed effects, and the coefficient of the lagged l*efp*$_{i,\ t}$ and $\gamma_{i,\ j}$ represents the coefficients of the lagged explanatory variables. After rewriting the above Eq. (3) into the error correction model (ECM), we proceed to employ the PMG estimator because of its robustness, consistency, and efficiency as compared to the Mean Group (MG) estimator considering that the homogeneity assumption holds. In Table 4, the dynamic estimate of the nexus of *efp* with the *arrival*, *global*, *gdp*, and the *biocap* is presented. The estimate further provides cross-section (country-specific) and short-run relationships among the investigated variables.

Robustness test

The part of the robustness tests employs the biocapacity (biocap) in lieu of the *efp* as the dependent variable in Eq. (1) such that the ARDL estimation procedure is repeated using the model presented in Eq. (4).

$$biocap = f|arrival, global, gdp, \text{efp}| \quad (4)$$

As a result, the output of the estimation is presented in Table 4 as model (b).

In a further observation of the nexus of the variables of interest, the Granger causality approach of Dumitrescu and Hurlin (2012) for heterogeneous non-causality is employed. The approach considers the asymptotic distribution given that the cross-section vis-à-vis N (10) is less than the time period vis-a-vis T (12). As such, the panel Granger causality approach is an appropriate expression as follows:

$$lefp_{i,t} = \alpha_i + \sum_{r=1}^{R} \beta_i^{(r)} lefp_{i,t-r} + \sum_{r=1}^{R} \gamma_i^{(r)} z_{i,t-r} + \varepsilon_{i,t} \quad (5)$$

By neglecting the fixed effect (α_i) of the cross-section from Eq. (4), the Granger causality from z to *efp* where $z = f$ (l*arrival*, l*global*, l*gdp*, and l*biocap*). In this case, each of the vector z (the independent variable) is employed singly along with the dependent variable (l*efp)*. Additionally, a

Table 3: Panel unit root test

Variable	LLC		IPS		Fisher-ADF	
	c	t	c	t	c	t
l*efp*	-1.108	-0.242	-0.194	0.165	23.770	24.407
l*arrival*	0.302	0.044	3.162	0.661	13.994	27.401
l*global*	-7.442*	-3.353*	-3.471*	-2.714*	51.961*	42.482*
l*gdp*	-2.338*	-1.770**	-0.075	-1.037	24.034	25.273
l*biocap*	-2.464*	-5.023*	-5.524*	-7.958*	79.707*	91.605*
Δl*efp*	-10.239*	-9.801*	-10.454*	-9.908*	127.909*	111.080*
Δl*arrival*	-8.637*	-4.984*	-8.222* -	-6.182*	98.267*	70.942*
Δl*global*	-8.822*	-8.912*	-6.439*	-5.828*	77.375*	66.723**
Δl*gdp*	-5.621*	-4.954*	-5.217*	-3.999*	64.655*	51.399*
Δl*biocap*	-9.775*	-6.151*	-14.041*	-11.026*	175.576*	125.173*

Cointegration test

Test	Kao residual cointegration test
ADF t-statistic = -1.653**(Probability value = 0.049) Residual variance = 0.0029 HAC= 0.0020	

Note: The notations * and ** are statistical significance at 1 and 5%, respectively. **Δ** indicates first difference. Lag selection by SIC of maximum of 4 in all estimations. LLC, IPS, and Fisher-ADF are the Levin et al. (2002); Im et al. (2003); Fisher-ADF by Maddala and Wu (1999) panel unit root tests. The c and t are the intercept and trend, respectively, and L implies the logarithmic transformation. Also, EFP, arrival, global, gdp, and biocap are respective the Ecological Footprint, International tourist arrivals, the Gross Domestic Product per capita, globalization, and biocapacity.

two-directional relationship for a pair of estimated variables with lag length R is equally presented by the approach presented in Eq. (5). It then suffices that the $\beta_i^{(r)}$ is the autoregressive parameter and the $\gamma_i^{(r)}$ is the coefficient for each estimated explanatory variable. Since the Granger causality approach assumes a heterogeneously normal distribution, the null hypothesis testing of homogenous non-stationary (HNC) is employed and illustrated as follows:

$$H0 = \gamma i = 0, \forall i = 1, 2, \ldots, N,$$
$$H1 = \gamma i = 0, \forall i = 1, 2, \ldots, N1; \gamma i \neq 0, \forall i = N1 + 1, N1 + 2, \ldots, N$$

given that $\gamma_i = (\gamma_i^1, \ldots, \gamma_i^R)$, $N_1 = N$ indicates that causality of any member of the panel but $N_1 = 0$ indicates causality within cross-sections as the value N_1/N is reasonably less than one. Subsequently, the result of the Granger causality with significant evidence of feedback and without feedback for different cases is presented in Table 5.

Results and discussion

The statistics presented in Table 2 are desirable especially from the perspective of the mean, median, skewness, kurtosis, and the Jarque-Bera statistics. For instance, across the countries and for the variables investigated (*efp*, *arrival*, *global*, *gdp*, and *biocap*), there seems to be no significant variance in the values of the mean and median. This suggests that the distribution of the variable such as the ecological footprint of France over time has not changed in an extreme or distorted manner. The evidence illustrated above is supported by the skewness and kurtosis statistical observations. Interestingly, the skewness for all the series is distributed between −1.0 and 0.5 or 0.5 and 1.0, indicating that all the series are all moderately skewed. Similarly, with the exception of the *arrival* and *biocap* in France, *biocap* in Spain and the USA, *global* in Italy, *efp*, *arrival*, and *biocap* in Mexico, and the *global* in Germany (which are Leptokurtic), all the series across the panel countries are Platykurtic. Hence, the largely Platykurtic distribution of the data implies that the series is not plagued with extreme values, thus it lacks outliers. These aforementioned observations are desirable and robust in the light of further observation of the general normal distribution as indicated by the Jarque-Bera statistics. The Jarque-Bera statistics show significant evidence of normal distribution for all the series across the panel countries except for *biocap* for Spain, *global* for Italy, *arrival*, and *biocap* for Mexico, *global* for the United Kingdom, and *global* for Germany.

In light of the cointegration property exhibited by the variables, empirical evidence through the Kao (1999) residual cointegration approach posits that the investigated series shares certain features over a time period. This implies that the trend of the variables jointly exhibits potential meandering over a specific period. A similar but in-depth result from the ARDL approach employed confirms that there is indeed cointegration evidence. The ARDL result thus presents the long-run relationships and the directional impacts of the *arrival*, *global*, *gdp*, and *biocap* on *efp*. As illustrated in Table 4, international tourist arrival and globalization exert a positive impact on the ecological footprint, thus suggesting that tourism activities in the destination countries potentially endangers the overall components of their ecosystems

Table 4: Pooled mean group test with dynamic ARDL specifications

Long-run	l*arrival*	l*global*	l*gdp*	l*biocap*	*Adjustment parameter*
(a) l*efp*	0.182*	0.891*	-0.864*	-0.563*	-0.205**
	l*arrival*	l*global*	l*gdp*	l*efp*	
(b) lbiocap	-0.500*	0.249**	1.149*	-0.552*	-0.387**
Short-run of cross-sections (Model a)					
1	-0.260*	0.460	1.591*	0.450*	N/S
2	0.214**	-0.417	1.648*	0.158*	-0.073*
3	0.005	0.567	1.171*	0.300*	-0.039*
4	-0.0472*	0.516	1.248*	0.137	N/S
5	-0.147**	-0.111	1.676*	-0.084	-0.055*
6	-0.413**	0.958	-0.893	1.568	-0.705*
7	-0.070	1.015	0.382	-0.201*	-0.053*
8	-0.000	-1.051**	1.048*	0.317**	-0/049*
9	-0.078*	-2.301*	1.145*	0.354*	-1.085*
10	-0.002	0.386	1.387*	-0.191	-0.030*

Note: (a) and (b) are models ARDL (1,1,1,1,1) and ARDL (2,3,3,3,3), respectively, selected by lag 1 and 3 of the Akaike Information Criteria. Also, EFP, arrival, global, gdp, and biocap are respective the Ecological Footprint, International tourist arrivals, the Gross Domestic Product per capita, globalization, and biocapacity. The variables are transformed to a logarithmic function denoted as L.

Table 5: Panel Granger causality results by Dumitrescu and Hurlin (2012)

Null hypothesis	w-stat	Direction of causality
l*arrival*→l*efp*	5.456*	Without feedback
l*efp*→l*arrival*	1.053	
l*global*→l*efp*	4.416*	With feedback
l*efp*→l*global*	2.501**	
l*gdp*→l*efp*	3.195*	Without feedback
l*efp*→l*gdp*	1.400	
l*biocap*→l*efp*	2.254**	With feedback
l*efp*→ l*biocap*	2.886*	
l*global*→l*arrival*	2.222**	Without feedback
l*arrival*→ l*global*	1.569	
l*gdp*→l*arrival*	1.326	Without feedback
l*arrival*→l*gdp*	4.742*	
l*arrival*→l*biocap*	2.136*	Without feedback
l*biocap*→l*arrival*	0.565	
l*gdp*→l*global*	3.116*	With feedback
l*global*→ l*gdp*	3.36	
l*global*→l*biocap*	2.111**	Without feedback
l*biocap*→ l*global*	0.751	
l*gdp*→l*biocap*	3.057*	Without feedback
l*biocap*→l*gdp*	1.395	

Note: * and ** are statistical significance level at 1 and 5%, respectively, and a lag selection of 1 is employed for the Granger causality estimate. Also, EFP, arrival, global, gdp, and biocap are respective the Ecological Footprint, International tourist arrivals, the Gross Domestic Product per capita, globalization, and biocapacity. The variables are transformed to a logarithmic function denoted as L.

especially in the long-run. It further suggests the demands from the activities of the visiting tourists and the trend of globalization in the panel of destination countries is significantly high, thus creating a distortion in the ecosystem. Although current studies tend to suggest contrary indication to some earlier studies (Gokmenoglu and Eren 2020; Bojanic and Warnick 2019; Baloch et al. 2020; Saint Akadiri et al. 2020a), the result from Etokakpan et al. (2020) and Usman et al. (2020) supports the evidence in the current study. Meanwhile, Saint Akadiri et al. (2020b) found that globalization is neutral to the trend of carbon emission in Turkey. On the contrary, the impacts of real *gdp* per capita (economic growth or wellbeing) and the biocapacity on the ecological footprint of the panel countries are significant and negative in the long-run. Also, Katircioglu et al. (2018) did not provide the long-run implication of the economic growth and ecological footprint nexus.

Similarly, by investigating the impacts of the same variables using the biological capacity (*biocap*), the implied results present robustness to the earlier result from the *efp* model. Also, in Table 4, we observe a negative and significant impact of tourist arrivals on biocap in the panel countries, especially in the long-run. This is an indication that tourism activities in the panel of destination countries hamper the reproductive capacity of the ecosystem, thus generating a sustainability concern. Accordingly, the result presents that globalization and the real income (economic growth) respectively increase the biocapacity of the ecosystem in the panel of destination countries. Expectedly, the ecological footprint of the panel countries causes a significant decline in the biological capacity of the ecosystem, thus posing a long-run sustainability debacle.

Subsequently, the short-run indication from Table 4 (also visually illustrated in Fig. 1) posits that tourism activities in France, China, Italy, Mexico, and Germany exert a negative effect on the ecological footprint. It implies that the volume of tourists' visits to the panel of destination countries would rather improve the quality of the environment. It is only in Spain that tourism activity is observed to induce ecological hazard while such impacts were reportedly not significant in the remaining countries. Interestingly, this same position is asserted by Katircioglu et al. (2018) and Bojanic and Warnick (2019). While Bojanic and Warnick (2019) found that the density of tourists in the tourism-dependent economies reduces GHG thus improves environmental quality, Katircioglu et al. (2018) equally posit that the environmental quality of the 10 destination countries is improved by tourism development. However, Wang et al. (2019) found that glacial tourism and destination are threatened by tourism activities by using the tourism heat footprint (THF). Also, like Katircioglu et al. (2018), *gdp* is observed to induce environmental degradation in the short-run in France, Spain, USA, China, Italy, Turkey, Germany, and Thailand. In Turkey and Germany, globalization is found to reduce environmental degradation in the short-run, but there is no significant impact of globalization in the other countries.

Lastly, the result of the Dumitrescu and Hurlin (2012) supports the short-run evidence earlier indicated (see Table 5). For instance, the past information of tourism activity and real *gdp* is good enough to explain the present dynamics of the ecological footprint. In the same vein, the history of globalization and expectedly that of the biocapacity are capable of explaining the ecological footprint dynamics and the causal relationships are bidirectional. In addition, the Granger causality from globalization and real income per capita to tourism is significant and without feedback. Moreover, there is a significant unidirectional Granger causality running from tourism arrivals, globalization, and real income per capita to biocapacity. The Granger causality between the variables is further demonstrated in Fig. 1.

Conclusion and policy insight

The current study did not only examine the core indicators of environmental quality and sustainability of the world's top 10 tourist destination countries; it captures this observation

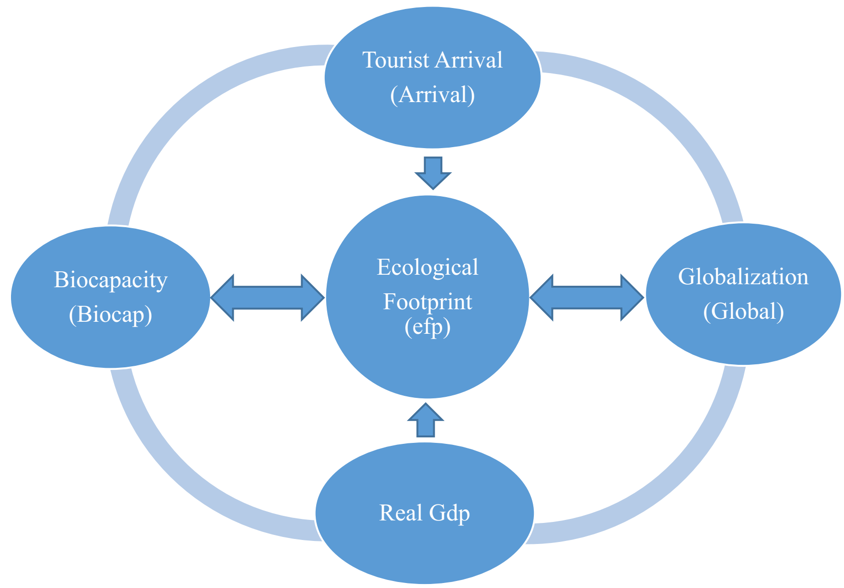

Fig. 1: An illustration of the directional relationship (Granger causality) between the ecological footprint, biocapacity, international tourist arrivals, real Gross Domestic Product, and globalization

within the framework of ecological footprint. Importantly, by employing the real *gdp* per capita, globalization, biocapacity, and the international tourist arrival as a proxy for tourism, the study further reveals the long-run nexus of these indicators with the ecological footprint. Similar studies have either fall short of investigating the dynamic long-run nexus or implementing the investigation with a more limited environmental variable (such as carbon emissions). Therefore, while employing the time period 1995–2016, the current study found that tourism activities in the panel of 10 most visited countries (France, Spain, USA, China, Italy, Mexico, United Kingdom, Turkey, Germany, and Thailand) are detrimental to environmental quality and its sustainability in the long-run. While real income per capita and the biological capacity (biocapacity) are observed to contribute to sustainable environment of the panel country, globalization and international tourism arrival to the destination countries will significantly lead to a setback in environmental sustainability. However, it is interesting to note that a surge in both tourist visitations to the destination countries and globalization has a significant negative impact on the ecological footprint in some of the examined countries in the short-run. This suggests that both indicators are far from causing harm to the environment in the short-run, rather they improve the quality of the environment in the immediate period. Similarly, the impacts of the real income per capita are largely undesirable in the short-run. To this end, the current study potentially underpins an interesting policy framework as follows:

- Since the short-run cross-section evidence of tourism-ecological footprint nexus suggests an ecologically friendly result in some of the examined destinations, the environmental sustainability strategy of the respective destination countries should be anchored on the long term sustainability approach. For instance, the expansion of the tourism sector in these countries should be matched with sustainable infrastructural development, technological innovation, and others. This could also be achieved by employing environmental policies such as ecotourism (nature-based tourism) and cultural tourism to further advance the destinations' sustainable development goals (SDGs) 2030.
- Also, because of the desirable impact of real *gdp* per capita on the ecosystem in the long-run, it suggests that the government of the respective countries and other stakeholders should further align other drivers of their economies within the sustainability pathway. An important vehicle for such a desired sustainable economy is the diversification of the energy portfolio by continuously increasing the (energy-mix) share of renewable energy. In addition, the prevailing conditions of the destination countries should enhance the availability of quality jobs that stimulate the economy without endangering the environment (Sustainable Development Goals 2019).
- Lastly, some of the aforementioned policies of the government should not be implemented in isolation considering the current century's drive toward globalization. Hence, certain issues such as trade policies (for example, trade in energy technologies) are expectedly considered with respect to another country.

In a future investigation, the dynamic determinants of the components of the ecological footprint could be investigated to further reveal the dire challenge of the ecosystem of the destination countries. The tourism-dependent economies could be more widely covered to further enrich the literature.

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Authors' contributions AAA worked on the estimation and as corresponding author, TTL was responsible for writing the introduction section, KKE worked on the literature section, and UVA contributed in the conclusion section of the manuscript.

Data Availability The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Competing interests The authors declare that they have no competing interests.

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