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RESEARCH ARTICLE

Effects of tourism, financial development, and renewable energy on environmental performance in EU-28: does institutional quality matter?

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Abstract
Institutional quality largely influences the ways in which economic agents align their production and operational behaviors towards expanding the share of renewable energy in the total energy mix and enhancing environmental performance. This study therefore explores the panel data for the EU-28 countries to assess the dynamic effects of institutional quality, tourism development, financial development, and renewable energy on environmental performance over the period 2002 to 2014. Using a two-step dynamic system generalized method of moments (GMM), the empirical results broadly suggest that institutional quality can be explored to dampen the potential negative effects of tourism and economic growth on environmental performance. In addition, financial development and renewable energy are positively related to environmental performance. This suggests that financial stability and energy consumption transition to renewable energy are necessary requirements to improve environmental performance. The policy implication for this study is that strengthening of institutional quality, financial stability, and adjusting to alternative and clean energy systems are the surest ways to achieve a cleaner and sustainable environment in the EU region.

Keywords Tourism development · Financialization · Renewable energy · Environmental performance · Institutional quality

JEL classification C23 · G23 · Q42 · Q56 · Z32

Introduction

One of the major goals of the European Union member countries (EU-28) in recent times is to mitigate environmental consequences of carbon dioxide (CO_2) accumulation and other greenhouse gasses (GHGs), which led to global warming and climate change. Following the Kyoto Treaty, the Paris Climate Conference (COP 21), and other wider global initiative to reduce the country-level greenhouse gasses (GHGs) emissions, EU countries as signatories to these agreements and conferences, have initiated a series of environmental policies and energy use strategies to reduce the usage of fuel oil and other traditional energy consumption patterns related to environmental issues in the region (see Ummalla et al. 2019; Apergis and Garcia 2019; Usman et al. 2019; Balsalobre-Lorente et al. 2018; Paramati et al. 2020; Dogan et al. 2019; Dogan and Inglesi-Lotz 2020; Ali et al. 2021).

Several studies have considered rapid worldwide tourism development, financial development, and energy use as the major driving forces behind environmental pollution (See Mavragani et al. 2016; Azam et al. 2018; Usman et al. 2020a, b; Agbanike et al. 2019; Destek and Sarkodie 2019; Iorember et al. 2020a; Usman et al. 2020d). The rapid development of tourism and the financial sector may lead to an upsurge in environmental degradation through an increase in energy consumption in the areas of transport, restaurant, and hotels, recreational centers, information technology, and so on and hence economic growth (Mamirkulova et al. 2020; Aman et al. 2019). However, the degree of their effects may be dependent on the quality of the institutions. For example, Bhattacharya et al. (2017) argue that the accumulation of

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carbon emission across countries is determined by the efficiency of institutions. A weak institution creates a fertile ground for environmental degradation, while a strong institution strengthens environmental improvement through total compliance with environmental laws. Usman et al. (2020a) reveal that the level of environmental performance is positively dependent on institutional quality such as good governance, degree of democratization and accountability, rule of law, corruption control, and political stability. This is because institutions normally exert pressure on economic agents to operate in a manner that does not harm the environment severely. Similarly, a recent study by Ali et al. (2019) and Azam et al. (2020) submits that institutional quality measured in terms of political stability, administrative capacity, and democratic accountability has improved the quality of the environment through its negative effect on the ecological footprint. The argument here is that institutional quality, such as market-based instruments (carbon taxes and subsidies), largely influences the ways in which economic agents align their production and operational behaviors towards enhancing environmental performance. In addition, Azam et al. (2020) show a positive relationship between institutional quality and fossil fuel-based energy use, suggesting that an increase in institutional quality increases CO_2 emission and declines environmental performance. This reaffirms the major conclusion in Mavragani et al. (2016) and Ozturk et al. (2019) that environmental performance responds positively to the reduction in corruption.

The European Union region is considered as an interesting case following its commitments to improving environmental quality in the region amidst several policies, which have aggressively increased tourism and financial sectors in the region over the years. According to the statistics reported by the United Nations World Tourism Organization (UNWTO) (2019), the growth of the international tourist arrivals to Europe in 2019 was 3.6% while the travel and tourism sectors generated roughly 14.4 million direct jobs in 2018 with about 2155.5 billion USD contribution to the gross domestic product (GDP) of the region. Moreover, the region has promoted renewable energy consumption over the years. As shown by the European Commission (2020), in 2019, the total primary production of renewables from all sources amounts to 1029 terawatt hours (TWh). This forms about 37.5% of the total primary energy production in 2019. Also, the share of renewable energy consumption in 2018 was 18.9% with the expectation that it will rise to 27% by 2030 based on the present commitments particularly in the area of investment in renewable energy research and development. This agrees with the position of literature that increasing the share of renewable energy in the energy mix improves the quality of the environment through a reduction in CO_2 emissions (Paramati et al. 2017; Zoundi 2017; Hanif 2018; Iorember et al. 2020a, b; Usman et al. 2020d).

To underpin the contributions of tourism and financialization to a sustainable environmental quality system, institutions should be strengthened to moderate the environmental effects of tourism and development. Theoretically, institutions can increase energy efficiency, which in turn improves environmental quality. Given this background, the main objective of the current study is to assess the effects of tourism development, financial development, renewable energy, and economic growth on environmental performance while controlling for institutional quality in the EU-28 countries Therefore, in this study, we do not only contribute to the literature by assessing the effects of tourism, financial development, and renewable energy on the EU environment as it is typical of other studies (see Usman et al. 2020a), but also we account for the role of institutional quality on environmental quality. In addition, we measure environmental quality by using the Environmental Performance Index (EPI), a policy-oriented dataset that evaluates comprehensively a country's environmental performance. The EPI is calculated as the weighted scores from an individual country's environmental performance based on 24 indicators, 10 issue categories, and 2 broad policy objectives as revealed in Appendix Table 7. Furthermore, our study combines five core measures of institutional quality indicators published by the Worldwide Governance Indicators (WGI) via the principal component approach in analyzing the moderating role of institutions in the tourism–financialization–renewable energy and environmental performance nexus in EU-28 countries. Methodologically, to circumvent serial correlation and heterogeneity problems, a two-step generalized method of moments (GMM) estimation approach is applied. All these constitute a clear departure from the extant literature.

The remaining sections of the paper are as follows: "Literature review" deals with the literature. "Data and methodology of research" presents and discusses the methodology of the study. "Empirical results and discussion" presents and analyzes the empirical results, and "Conclusion" concludes the paper and makes policy recommendations.

Literature review

The extant literature indicates mixed findings regarding the influence that tourism exerts on the environment. For instance, using the augmented autoregressive distributed lag (ARDL), Anser et al. (2020) found that inbound tourism decreases environmental performance through an increase in carbon emissions. Ahmad et al. (2018) examine the effect of tourism on environmental pollution from the One Belt One Road provinces of Western China using the fully modified ordinary least square (FMOLS) and the Gregory–Hansen test for robustness check. Findings from the study show a negative effect of tourism on the environment for Ningxia, Qinghai, Gansu, and

Table 1 Summary of the empirical literature

Author	Country	Time covered	Methodology	Result
Katircioğlu (2014)	Singapore	1971–2010	Maki cointegration and DOLS	Tourism development reduces CO_2 emissions
Usman et al. (2020a)	EU-28	2002–2014	Two-step system GMM	Tourism decreases environmental performance. Institutional quality increases environmental performance
Mahjabeen et al. (2020)	D-8 countries	1990–2016	Panel ARDL, FMOLS, and DOLS	Institutional quality has a decreasing effect on CO_2 emission
Haldar and Sethi (2020)	39 developing countries		The battery of mean group tests GMM and panel FMOLS	Institutional quality abates CO_2 emission through energy use
Sarkodie and Adams (2018)	South Africa	1971–2017	Response surface regressions and structural break cumulative sum (CUSUM) test	Institutional quality has a positive effect on environmental quality
Mavragani et al. (2016)	75 countries including G-20	2006–2016	Factor analysis	Institutional quality has a positive influence on environmental performance
Apergis and Garcia (2019)	EU-28 countries	1995–2014	Data envelopment analysis (DEA) approach	Governance quality influences environmental quality via energy efficiency policies
Shahbaz et al. (2020)	United Arab Emirates	1975–2014	structural break and cointegration tests and Toda–Yamamoto	Financial development is positively linked to environmental degradation
Acheampong (2019)	46 sub-Saharan African countries	2000–2015	System GMM	Financial development has an increasing effect on CO_2 emission
Danish and Wang (2018)	BRICS	1995–2014	A battery of econometric tests robust to heterogeneity and cross-sectional dependence	Tourism degrades the environmental quality
Dogan and Seker (2016)	Top renewable energy countries	1985–2011	FMOLS and DOLS	Renewable energy and financial development reduce emission levels
Dogan et al. (2020)	OECD countries	1990–2010	OLS-FE and quantile regression	Renewable energy blasters economic growth for lower and low-middle quantiles, while the effect is negative for middle, high-middle, and higher quantiles
Mikayilov et al. (2019)	Azerbaijan	1996–2014	Time-varying coefficient cointegration approach (TVC)	Tourism deteriorates the environmental quality
Rasekhi and Mohammadi (2015)	Caspian Sea nations	2002–2013	Panel vector autoregressive (P-VAR) model	Tourism has a negative relationship with environmental performance
Ahmad et al. (2018)	Provinces of Western China	1991–2016	FMOLS and Gregory–Hansen tests	Tourism has both positive and negative effects on environmental quality depending on the level of growth
Azam et al. (2018)	Malaysia, Thailand, and Singapore	1990–2014	FMOL	Tourism increases pollution in Malaysia but decreases it in Thailand and Singapore
Sadorsky (2009)	G7 countries	1980–2005	Panel cointegration	Real GDP, CO_2 emissions are drivers of renewable energy
Iorember et al. (2020a)	Nigeria	1990–2016	Bayer–Hanck cointegration, ARDL, and VECM causality	Renewable energy consumption improves environmental quality
Iorember et al. (2020b)	South Africa	1990–2017	Maki cointegration, ARDL, and VECM causality	Renewable energy use increases the quality of the environment
Ike et al. (2020a)	G-7 countries	1960–2014	FMOLS, DOLS, and P-VECM causality	Renewable energy has a negative link with environmental quality
Shahbaz et al. (2018)	France	1955–2016	Bootstrap bounds testing/ARDL	EKC holds for France, and financial development is required to reduce carbon emissions
Usman et al. (2019)	India	1971–2014	Bayer–Hanck, ARDL, and VECM causality	Economic growth has a positive link with environmental degradation
Balsalobre-Lorente et al. (2018)	EU-5 countries (Germany, France, Italy, Spain, and the UK)	1985–2016	Panel least squares with correction for heteroscedasticity	Economic growth exerts a positive effect on environmental degradation

Shanxi while improving the environmental quality of Xinjiang. In another study, Cadarso et al. (2015) established a strong positive relationship between tourism and carbon emission, suggesting that both domestic and international trips contribute to decreasing the quality and performance of the environment through an increased level of CO_2 emission. Applying Granger causality based on the vector error correction model (VECM), Ben Jebli and Hadhri (2018) found evidence supporting the negative effect of tourism on CO_2 emission, suggesting that tourism improves environmental quality despite its huge contribution to economic growth. Similarly, the study of Sghaier et al. (2019) reveals a decreasing effect

Table 2 Summary statistics

Variables	Mean	Std. dev.	Min	Max	Obsv.
EPI	70.0375	7.87335	45.5500	84.7300	364
IQ	−2.71e-08	1.41023	−4.04955	3.97114	364
lTRD	22.4762	1.30062	18.8969	24.8992	364
lFD	−0.61425	0.40088	−2.02666	−0.05298	364
lRENE	2.31863	1.05541	−2.43831	3.91099	364
lEG	10.1450	0.68166	8.41911	11.6260	364

between tourism and environmental quality in Egypt while increasing and neutral effects are established in Tunisia and Morocco, respectively. Using a battery of econometric tests that are robust to heterogeneity and cross-sectional dependence, Danish and Wang (2018) examined the dynamic nexus among tourism, economic growth, and CO_2 emissions for Brazil, Russia, India, China, and South Africa (BRICS) countries. The empirical results reveal that tourism degrades environmental quality via economic growth.

Regarding the effect of financial development, the existing literature in support of the influence of financialization on the environment establishes that a vibrant financial system creates investment opportunities in environment-friendly energy projects by offering low-interest loans and providing incentives to environmental compliance energy firms (see Iorember et al. 2020b; Destek and Sarkodie 2019; Adams and Klobodu 2018). Financial development also influences the environment through economic growth (Shahbaz et al. 2020; Iorember et al. 2020a; Jelilov et al. 2020; Goshit and Iorember 2020; Abbas et al. 2019a; Hussain et al. 2021; Abachi and Iorember 2017; Dalis et al. 2020). That is, an increase in economic growth due to financialization is closely linked to an increase in energy use, and it may contribute to environmental deterioration.

Furthermore, the literature is active regarding the roles that institutions play in ensuring a sustainable environment. Accordingly, Usman et al. (2020a), Ali et al. (2019), stated that institutional quality (good governance, the extent of democratization, rule of law, corruption control, effective tax system, political stability, etc.) has a positive influence on economic agents in adhering to environmental laws and operating in ways that do not harm the environment severely. More recently, studies by Azam et al. (2020) and Ali et al. (2019) found that institutional quality measured in terms of political stability, administrative capacity, and democratic accountability has a positive and significant effect on the environmental quality expressed in terms of ecological footprint. This is because institutional frameworks such as market-based instruments (carbon taxes and subsidies) to a large extent influence how economic agents align their production and operational behaviors towards enhancing environmental performance. Similarly, Ozturk et al. (2019) and Mavragani et al. (2016) reveal that environmental performance responds positively to the reduction in corruption. Further, the study of Azam et al. (2020) shows a positive relationship between institutional quality and CO_2 through fossil energy use, thereby suggesting a decline in environmental performance. Also, studies by Iorember et al. (2019) and Abbasi et al. (2021a, b; Abbas et al. 2021) show that a sustainable energy mix with a reasonable proportion of renewable energy leads to economic and environmental sustainability. Further related literature is summarily presented in Table 1.

Data and methodology of research

Data for the study

The data used in the estimations consist of a balanced panel drawn from different data sources over the period 2002 to 2014 based on 28 European countries (EU-28). The starting period for the study, which is 2002, and the ending period, which is 2014, are influenced by data availability. Particularly, the EPI dataset begins in 2002, and it is available on a yearly basis until 2014, after which it ceases to be computed on a yearly basis by the data provider. Therefore, to avoid measurement errors due to the interpolation of data, we limit our study to the period 2002–2014. The variables in the estimations include the Environmental Performance Index (EPI) which

Table 3 Correlation matrix

Variable	EPI	IQ	lTRD	lFD	lRENE	lEG
EPI	1.00000					
IQ	0.06858	1.00000				
lTRD	0.45243***	0.02025	1.00000			
lFD	0.62769***	0.04697	0.71892***	1.00000		
lRENE	−0.12639**	−0.05552	−0.02791	−0.21871***	1.00000	
lEG	0.64154***	0.03626	0.50660***	0.83562***	−0.19492***	1.00000

Notes: *** and ** indicate levels of significance at 1% and 5%

is the dependent variable. The independent variables include institutional quality index (IQ), economic expansion measured by real gross domestic product (EG), tourism development (TRD), broad-based financial development index (FD), and renewable energy (RENE) as tabulated as shown in Appendix Table 8: real GDP, tourism, financial development, and renewable energy are in their natural logarithms while EPI and IQ are not.

Theoretical framework and model specification

Theoretically, the link between economic growth and environmental quality has been well-established in the literature following the empirical works of Grossman and Krueger (1991) (see Ozturk et al., 2016; Dogan and Turkekul 2016; Apergis 2016; Ike et al. 2020a, b; Rafindadi and Usman 2019). According to Grossman and Krueger (1991), the first stage of economic development is such that the income level increases with the level of carbon emissions, leading to environmental degradation until a certain level of income is reached, after which the level of environmental degradation will begin to decline through a decline in the level of carbon emissions. This hypothesis is known as the environmental Kuznets curve (EKC) in the literature of energy economics. As mentioned in the introductory section, over the years, EU countries have attracted huge tourism inflow than any other region. This region has also experienced an energy transition from fossil fuel energy consumption to renewable energy consumption as well as the development of financial institutions and markets. These may cause drastic changes in their efforts towards achieving the sustainability development goals of the United Nations by 2030. Therefore, in this study, to capture the economic and social aspects, we incorporate institutional quality, tourism, financial development, and renewable energy into the environment–economic growth nexus for EU-28 countries. Our empirical model is specified as follows:

$$EPI_{i,t} = f\left(\mathrm{IQ}_{i,t}\mathrm{TRD}_{i,t}, \mathrm{FD}_{i,t}, \mathrm{X}_{i,t}\right) \tag{1}$$

where EPI denotes the Environmental Performance Index.[1] IQ represents institutional quality and $lTRD$ and lFD are the log of tourism and financial development, respectively, while X represents the vector of additional controlled variables that have been found relevant in determining environmental performance such as renewable energy (RENE) and economic growth (EG). Hence, the functional relation with natural logarithm expression of Eq. (1) is given as

$$EPI_{i,t} = \alpha_i + \alpha_1 \mathrm{IQ}_{i,t} + \alpha_2 \mathrm{lTRD}_{i,t} + \alpha_3 \mathrm{lFD}_{i,t} + \alpha_4 RENE_{i,t} + \alpha_5 EG_{i,t} + \varepsilon_{i,t} \tag{2}$$

where α in the equation is referred to as the constant. TRD, FD, $RENE$, and EG are in their natural logarithms to help stabilize variances. ε is the error term invariably assumed to have a zero mean. The i and t subscripts represent countries (cross-sectional units) and time where i is the ith series ($i = 1, \ldots, 28$) and $t = 2002, \ldots, 2014$.

A two-step system generalized method of moments (GMM) developed by Blundell and Bond (1998) is explored to examine the contagious effects of tourism and financial development on environmental performance based on Eq. (2). The scope of this study is in agreement with the motivation for the study, while the corresponding period for the study is contingent on the availability of data.[2] The decision to make use of the GMM approach is informed mainly by the following factors: first, a two-step GMM estimator controls for the serial correlation and heterogeneity, which remain as major weaknesses of the panel data modeling. Second, the number of our countries in our study is larger than the number of years considered in this study, allowing for the application of the GMM model. Third, the issue of cross-country variations in the panel is greatly controlled for in the GMM regressions. Fourth, the issue of simultaneity bias in the independent variables is accounted for by using the appropriate instruments, which are time invariant. Fifth, it corrects for inherent biases in the difference-based estimation (Baltagi 2008; Roodman 2009; and Asongu 2018).

The GMM estimation employed in this study is an extension of the Arellano and Bover (1995) model of difference GMM advanced by Roodman (2009). This approach accounts for cross-sectional dependence as demonstrated by Baltagi (2008), Asongu (2018), Usman and Yakubu (2019) and Mubeen et al. (2020). The procedure of the system GMM estimation is summarized as follows:

$$EPI_{i,t} = \alpha_0 + \alpha_1 EPI_{i,t-\tau} + \alpha_2 IQ_{i.t} + \alpha_3 lTRD_{i.t} + \alpha_4 lFD_{i.t} + \sum_{j=1}^{k} \sigma_j X_{j,i,t-\tau} + \eta_i + \xi_t + \varepsilon_{i,t} \tag{3}$$

$$EPI_{i,t} - EPI_{i,t-\tau} = \alpha_1\left(EPI_{i,t-\tau} - EPI_{i,t-2\tau}\right) + \alpha_2\left(\mathrm{IQ}_{i.t} - \mathrm{IQ}_{i.t-\tau}\right) + \alpha_3\left(\mathrm{l}TRD_{i.t} - lTRD_{i.t-\tau}\right) + \alpha_4\left(lFD_{i.t} - lFD_{i.t-\tau}\right) + \sum_{j=1}^{k} \sigma_j\left(X_{j,i,t-\tau} - X_{j,i,t-2\tau}\right) + \left(\xi_t - \xi_{t-\tau}\right) + \varepsilon_{i,t-\tau} \tag{4}$$

[1] The Environmental Performance Index (EPI) is a comprehensive measurement of environmental quality computed based on 24 indicators, 10 issue categories, and 2 broad policy objectives.

[2] The starting period is influenced by the availability of data for institutional quality, while the ending period is due to the availability of the EPI dataset on a consecutive yearly basis.

Table 4 Panel unit root tests

	IM–Pesaran–Shin unit root tests			
	At levels		First difference	
	Statistic	*p* value	Statistic	*p* value
EPI	−4.4130	0.0000	−4.5238	0.0000
IQ	0.4712	0.6812	−6.9745	0.0000
lTRD	−4.0488	0.0000	−6.3262	0.0000
lFD	−2.0299	0.0212	−6.5764	0.0000
lRENE	−7.4956	1.0000	−7.1645	0.0000
lEG	−1.1618	0.1227	−4.3473	0.0000
LCO_2	6.9811	1.0000	−8.3805	0.0000

Note: The null hypothesis is that there is cross-sectional independence across countries in the panel

where *EPI*, *IQ*, *lTRD*, *lFD*, and *lX* retain the definition given in Eqs. (1) and (2). The coefficient of autoregression is denoted by τ, while ξ_t is the time-specific constant in the model. We capture the country-specific effect by η_t, while the residual term is represented by ε_t. The subscripts *i* and *t* are the countries and time period in the GMM model. Theoretically, increases in tourism development and economic growth are expected to reduce environmental sustainability and increase CO_2 emission, while increases in institutional quality and renewable energy are expected to increase environmental sustainability and reduce CO_2 emission. The effect of financial development can be either positive or negative depending on the effective management of the environment.

Table 5 Two-step SYS-GMM estimates

Variable	Coefficient	Std. error	*p* value
EPI	0.2706	0.0075	0.000
IQ	0.4116	0.1217	0.001
lTRD	−0.9025	0.4192	0.031
lFD	8.1308	1.3943	0.000
lRENE	1.6450	0.2694	0.000
lEG	−4.9491	1.4205	0.000
Constant	89.165	9.9482	0.000
Diagnostic tests			
AR (1) *p* value	−1.9887	0.0467	
AR (2) *p* value	−0.8681	0.3923	
Sargan test (*p* value)	(1.0000)		
Hansen test (*p* value)	(0.2506)		
Instruments	23		
Observations	336		
No. of countries	28		

Notes: EPI is a dependent variable

Table 6 Two-step SYS-GMM estimates

Variable	Coefficient	Std. Error	*p* value
lCO_2	0.7190	0.0596	0.000
IQ	0.0086	0.0016	0.000
lTRD	0.1024	0.0134	0.000
lFD	0.1182	0.0213	0.000
lRENE	−0.0681	0.0184	0.000
lEG	0.1762	0.0588	0.003
Constant	1.3002	0.3625	0.000
Diagnostic tests			
AR (1) *p* value	−4.0099	0.0001	
AR (2) *p* value	−1.5823	0.1136	
Sargan test (*p* value)	(1.0000)		
Hansen test (*p* value)	(0.2760)		
Instruments	23		
Observations	336		
No. of countries	28		

Notes: CO_2 emission is a dependent variable

Empirical results and discussion

Preliminary analysis

We begin the analysis by reporting the summary statistics of the variables employed in this study as shown in Table 2. Evidently, the mean score of EPI is the largest, while IQ and lFD are not only small but also negative. The standard deviation values, apart from EPI, tend to be small, which suggests a low level of volatility in the variables. The correlation matrix of the variables as reported in Table 3 indicates environmental performance is positively and insignificantly correlated with institutional quality. The environmental performance also correlates positively with tourism, financial development, and economic growth with evidence of statistical significance. The correlation between renewable energy and economic growth is negative and statistically significant. Similarly, the correlation between all other variables with renewable energy is negative and only significant in the cases of environmental performance and financial development.

Empirical results

The results of the Pesaran (2004) test for cross-sectional dependence are presented in Appendix Table 9. The result reveals that the null hypothesis of cross-sectional independence is rejected at a 1% level of significance for all the variables except the institutional quality index. This, therefore, means

[0] An anonymous referee has suggested the need to test for cross-sectional dependence and unit root among the variables in the model.

that there is a cross-sectional dependence in the variables except for institutional quality. Furthermore, we conduct a unit root test as shown in Table 4.[3] The result indicates that Environmental Performance Index, tourism development, and financial development are all integrated of order zero, that is, I(0); while institutional quality, renewable energy consumption, economic growth, and carbon dioxide emissions are only stationary after taking their first differences. This implies that these variables are I(1).

Table 5 presents the empirical results based on the dynamic system GMM regression. The results indicate that the effect of institutional quality on environmental performance is positive and statistically significant ($\alpha_1 = 0.4116,\ \ p < 0.01$). This implies that an increase in institutional quality would stimulate environmental improvement. The effect of financial development on environmental performance is positive and significant, ($\alpha_3 = 8.1308,\ \ p < 0.01$). The result also finds an increase in renewable energy to exert upward pressure on environmental performance, that is, ($\alpha_4 = 1.6450,\ \ p < 0.01$); while tourism development and economic growth impede environment performance as shown by their coefficients, that is, ($\alpha_2 = -0.9025,\ \ p < 0.05$) and ($\alpha_3 = -4.9491,\ \ p < 0.01$).

To examine the robustness of our estimated results, we repeat the analysis by considering carbon dioxide (CO_2) emissions as a dependent variable. The empirical results as reported in Table 6 reveal that while renewable energy helps reduce CO_2 emissions, tourism development and economic growth exert positive pressure on CO_2 emissions. This finding is therefore robust to our earlier result when environmental performance is used as a dependent variable. Furthermore, the positive effects of institutional quality and financial development are not robust to our earlier finding, and as such, contrary to theoretical expectations as mentioned under model specification in "Data and methodology of research." Therefore, our finding is consistent with Usman et al. (2020b) and Alhassan et al. (2020) who aver that the Environmental Performance Index provides more reliable results compared to other measures of environmental degradation.

To check the validity of the GMM model, we employ two principal informational criteria. In the first place, we present the second-order autocorrelation test (AR[2]) suggested by Arellano and Bover (1995). This is more powerful to detect autocorrelation in the GMM than the corresponding first-order autocorrelation test (see Asongu and Nwachukwu 2016; Usman et al. 2019; Usman et al. 2020a). Secondly, we test for the validity of the instruments in the system GMM using the Sargan and Hansan tests. Unlike the Hansen test, the Sargan test for the validity of the instrument is not weakened by the instruments. As shown in the bottom of Table 5 and in its robustness checking in Table 6, the Sargan and Hansen tests of overidentification restrictions could not reject the null hypothesis that overidentification restrictions are valid in both models. This suggests that the instrumental variables are not correlated with the error term. In the same manner, the instruments in the estimations show that they are not overidentified as the number of instruments in each specification is less than the corresponding number of cross sections. Also, the results of the Arellano–Bond test for zero autocorrelation in first-differenced errors show that the null hypothesis of no autocorrelation could not be rejected. Overall, the system GMM models employed in this study are adequate as there are no overidentification restrictions and autocorrelations. Furthermore, we applied the predictive margins with a 95% confidence interval as shown in Fig. 1 and Fig. 2 (see Appendix D1 and Appendix D2, respectively). The plot displays high predictive margins of the GMM model estimations. The result shows that the model is adequate.

Discussion of empirical results

The results reveal that institutional quality, financial development, and renewable energy stimulate environmental performance, while tourism development and economic growth impede environmental performance. There is a plausible reason for the positive relationship between institutional quality and environmental performance. One of these reasons is that a strong institutional quality could put pressure on the economic agents to operate in line with the existing legal framework as shown by Usman et al. (2020a). Secondly, an environment where economic and political institutions are adequately performing could influence firms that are the major emitters of carbon dioxide and greenhouse gases to adhere to stringent environmental laws through market-based instruments such as carbon taxes and subsidies. Institutional quality could also enhance environmental improvement through a fall in the level of corruption. Therefore, our finding is consistent with Mavragani et al. (2016) and Ozturk et al. (2019) who attribute a decline in environmental pollution to a decline in corruption due to improvement in environmental quality. The results also concur with Usman et al. (2020a) who found environmental quality as an impetus for improving environmental performance in the EU countries. However, our results disregard the recent finding documented by Azam et al. (2020) that institutional quality increases fossil-based energy consumption.

The positive relationship between financial development and environmental performance indicates that financial stability is an essential condition required for improving environmental performance by lowering CO_2 emissions. This becomes obvious in a regional economy such as EU countries where the region has heavily invested in renewable energy in the past two decades. Therefore, the energy growth effect of financial development is pollutant free because the

[3] An anonymous referee has suggested the need to test for cross-sectional dependence and unit root among the variables in the model.

share of renewable energy in the total energy consumed by this region is high. This finding is in line with Dogan and Seker (2016) who reported that financial development improves the quality of the environment in the top countries listed in the renewable energy attractiveness index. Our finding is similar to Nasreen and Anwar (2015) and Shahbaz et al. (2016, 2018) who documented that financial development is inversely related to environmental degradation. On the contrary, Usman et al. (2020c) reported financial development to have stimulated ecological footprint in the USA.

The results also provide that renewable energy promotes environmental improvement. This is because the region has spent a huge amount on research and development in modern renewable energy and technologies over the years. As reported by the European Commission (2020), the primary production of renewable energy from all sources in the EU countries accounts for about 1029 TWh, that is, 37.5% of its total primary energy production in 2019. Therefore, our result is consistent with Usman et al. (2020c) that renewable energy reduces environmental degradation through a decrease in the ecological footprint of the USA. It is also consistent with Ike et al. (2020a) that renewable energy promotes environmental quality in G7 countries. Our results also concur with Paramati et al. (2020) that increasing renewable energy would reduce CO_2 emission in the EU member countries in the long run. On the contrary, this finding is in disagreement with Apergis et al. (2010) who submitted that renewable energy has no substantial role in reducing environmental pollution in 19 advanced and emerging economies. We also find our result to be different from Ben Jebli et al. (2015) that the role of renewable energy on carbon emissions for sub-Saharan African countries is mixed.

Furthermore, our results provide that tourism and economic growth mount negative pressure on environmental performance by stimulating demand for energy consumption in tourist attraction management, hotel and restaurant, recreational centers, and hence economic growth. This finding is consistent with Katircioğlu (2014); Katircioğlu et al. (2014); Usman et al. (2020a, b, e); Dogan et al. (2019); and Dogan and Inglesi-Lotz (2020) who found that tourism demand would deteriorate the environmental quality through its positive effect on economic growth. Generally, the implication for the finding is that the pursuit of tourism and economic growth hurts the environment and consequently hinders the realization of sustainable development goal (SDG) targets by the United Nations in the EU region by 2030.

Conclusion

Given the rapid development of tourism, financial development, and renewable energy and economic growth in the EU-28 countries, this study assesses not only the effects of the growth of these variables on the regional environmental performance but also consider whether institutional quality matter within the limit of resources to attain cleaner environment in this region. In achieving this, we employ a two-step system GMM regression, which is capable of addressing the endogeneity problem in the environmental performance function. In this paper, we contribute to the literature by using an Environmental Performance Index, which is more comprehensive as it measures 24 indicators of environmental quality, 10 issue categories, and 2 broad policy objectives. The results reveal that while tourism and economic growth cause downward pressure on environmental performance, financial development, renewable energy, and institutional quality cause upward pressure on environmental performance if all other factors remain unchanged. Moreover, the negative effects of tourism and economic growth on environmental performance can be dampened by the quality of the institutions. These findings are not totally robust when CO_2 emission is applied to measure environmental quality.

Policy recommendations

Based on the findings of this paper, we recommend several policy measures to achieve environmental improvement in the region. First, the consumption of fossil-based fuels which has been the major driver of tourism development and economic growth in the region should be reduced. To this effect, government and energy policymakers need to adopt alternative and clean energy systems such as renewables and other alternative uses of energy to sustain environmental quality in the EU region. Second, the quest to stimulating the tourism sector should be carried out with caution so as not to jettison the long-term target of achieving carbon-free economies in the region. Third, in transitioning to renewable-based energy consumption, it is recommended that the principle of comparative advantage should be considered as a priority to minimize the cost of acquiring renewable energy.

Finally, we suggest that future research in this area should consider quantile regression-based models which would make use of the entire distribution of the environmental performance. This will provide policymakers with information about the entire conditional distribution of the environmental performance. Chances are that the effects of the explanatory variables on the environment performance may differ at lower, middle, and upper quantiles.

Appendix 1

Table 7 Environmental Performance Index (EPI) matrix for each country

Policy objective		Issue category		Indicator
Title	Abbrev	Title	Abbrev	Title
Environmental health (40%)	HLT	Air quality (26%)	AIR	Household solid fuels (10.4%)
				$PM_{2.5}$ exposure (7.8%)
				$PM_{2.5}$ exceedance (7.8%)
		Water and sanitation (12%)	H_2O	Drinking water (6%)
				Sanitation (6%)
		Heavy metals (2%)	HMT	Lead exposure (2%)
Ecosystem vitality (60%)	ECO	Biodiversity and habitat (15%)	BDH	Marine protected areas (3%)
				Biome protection (national) (3%)
				Biome protection (Global) (3%)
				Species protection Index (3%)
				Representativeness Index (3%)
				Species Habitat Index (1.5%)
		Forests (6%)	FOR	Tree cover loss (6%)
		Fisheries (6%)	FSH	Fish stock status (3%)
				Regional Marine Trophic Index (3%)
		Climate and energy (18%)	CCE	CO_2 emissions — total (9%)
				CO_2 emissions — power (3.6%)
				Methane emissions (3.6%)
				N_2O emissions (0.9%)
				Black carbon emissions (0.9%)
		Air pollution (6%)	APE	SO_2 emissions (3%)
				NO_X emissions (3%)
		Water resources (6%)	WRS	Wastewater treatment (6%)
		Agriculture (3%)	AGR	Sustainable nitrogen management (3%)

Source: World Economic Forum, Yale Centre for Environmental Law and Policy, 2018

Appendix 2

Table 8 Variable, measurement, and source

Variable	Measurement	Source
Environmental Performance Index (EPI)	Measured with 24 indicators, 10 issue categories, and 2 broad policy objectives with weights at each level as % of the total score	Socioeconomic Data and Application Centre (SEDAC): http://www.ciesin.columbia.edu/indicators/ESI/
Tourism development (TRD)	Total number of international tourism receipts	World Development Indicator
Institutional quality index (IQ)	Index of regulatory quality, government effectiveness, rule of law, control of corruption, political stability, and absence of violence/terrorism, measured by −2.5 for weak governance and+2.5 for strong governance	Worldwide Governance Indicators
Financial development (FD)	Index of the financial institution and financial market measured based on depth, access, and efficiency	International Monetary Fund (IMF)
Economic expansion (GDP)	Gross domestic production (constant 2010 USD) per capita	World Development Indicator
Renewable energy (RENE)	Share of renewables to total primary energy supply measured in thousand tons (tons of oil equivalent)	Organization for Economic Co-operation and Development (OECD)

Source: Authors' computation

Appendix 3

Table 9 Pesaran test for cross-sectional dependence

Variable	C-D test	*p* value	Corr.	Abs(Corr)
EPI	37.17	0.000	0.530	0.726
IQ	−1.61	0.106	−0.023	0.490
lTRD	61.84	0.000	0.882	0.882
lFD	32.82	0.000	0.468	0.518
lRENE	61.57	0.000	0.878	0.878
lEG	42.01	0.000	0.599	0.661

Note: The null hypothesis is that there is cross-sectional independence across countries in the panel

Appendix 4 Predictive margins plot of SYS-G (with EPI as the dependent variable)

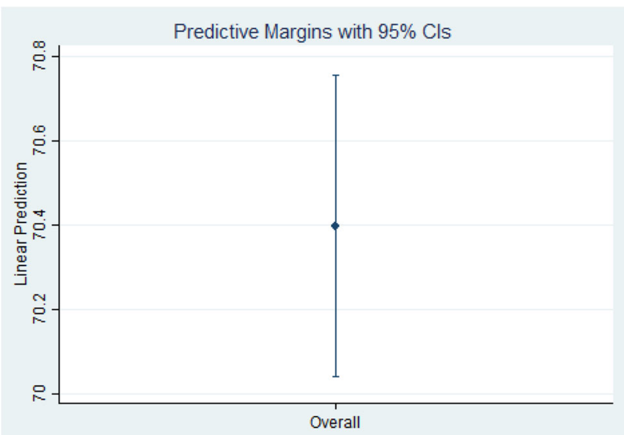

Fig. 1 Predictive margins plot of SYS-GMM (with EPI as the dependent variable)

Appendix 4: Predictive margins plot of SYS-G (CO_2 as the dependent variable)

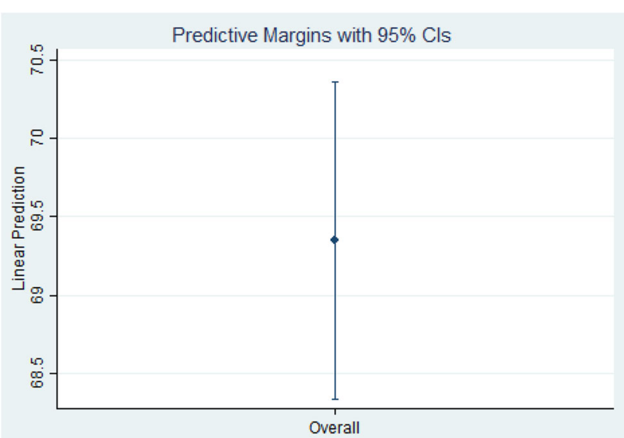

Fig. 2 Predictive margins plot of SYS-GMM (CO_2 as the dependent variable)

Availability of data and materials The datasets generated and/or analyzed during the current study are available in the repositories:

- Environmental Performance Index: The index is available on a yearly basis at Socioeconomic Data and Application Centre (SEDAC): http://www.ciesin.columbia.edu/indicators/ESI/.
- Renewable energy per capita is available in the OECD database.
- Institutional quality index: The variables are available at the Worldwide Governance Indicators.
- Financial development index is available at the International Monetary Fund (IMF) database.
- GDP per capita and tourism development are available at the World Development Indicators (WDI, 2019).

Author contribution Muhammad Sani Musa: conceptualization and writing—original draft, supervision, validation, and visualization. Ojonugwa Usman: conceptualization, data curation, formal analysis, investigation, and methodology. Gylych Jelilov: writing—original draft, Writing—review and editing, validation, visualization, and supervision. Paul Terhemba Iorember: data curation, writing—original draft, Writing—review and editing and formal analysis.

Declarations

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