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The impact of e-commerce on environmental sustainability targets in selected European countries

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ABSTRACT

E-commerce plays a crucial role in the digital economy. E-commerce can reduce costs and boost economic growth. Therefore, the global rate of E-commerce is increasing very fast, which has implications for the digital economy. This study analyses the impact of e-commerce on environmental sustainability. The empirical analysis employed OLS, 2SLS, GMM, and panel quantile regression methods using panel data of 10 European economies spanning over 2002–2019. Carbon emissions and GHG emissions measure environmental sustainability. The results from OLS, 2SLS and GMM show that e-commerce negatively impacts carbon emissions. The panel quantile regression results also show that e-commerce negatively impacts carbon emissions at the middle and higher quantiles. This study recommends that environmental sustainability programs pay attention to policies encouraging e-commerce.

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1. Introduction

There exists intensifying consensus between academics and development agencies on the prospective role of E-commerce on human well-being. ICT and the internet are continuously growing in the public sector, private sector, and domestic level in both developing and industrialised economies. E-commerce has gained widespread coverage in trade and research publications, reporting various successful stories (Oláh et al., 2018). To analyse and gather evidence about the role of E-commerce, there is a need to understand the transmission channel between technology and human well-being(Ielasi et al., 2018). Previous studies on E-commerce mainly focussed on identifying the impact of E-commerce on national infrastructures, such as physical, technological, financial, and institutional. E-commerce can upsurge environmental sustainability through the channel of social-economic development (Chen, 2019; Chen & Yan, 2020). To get a

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broader perspective of E-commerce's impact on environmental sustainability, we have to involve ourselves in the debate on how environmental sustainability is determined. To determine how E-commerce can affect the environment, one must understand the true meaning of 'environmental sustainability.'

Extant studies tend to suggest various diversified definitions for E-commerce (Lin et al., 2019). Existing literature outlines the following four definitions of E-commerce. E-commerce involves delivering services/products, information, and payments through computer networks, telephone lines, or any other sources from the communications viewpoint. From the business viewpoint, E-commerce involves advanced technology applications for the mechanisation of business workflow and transactions (Cao et al., 2021). From the service viewpoint, E-commerce works as an instrument that considers the desire of consumers, management, and firms to amend service costs while enhancing the service delivery speed and increasing the quality of products (C. W. Su et al., 2022). From the online viewpoint, E-commerce offers the capability of selling and buying products and related information on the online services and the internet (Su et al., 2022; Tao et al., 2022a, b).

Hence, E-commerce is based on different viewpoints and conceptualizations, including the level of integration and nature of the technology involved (Su et al., 2022). Our study adopts the basic aspects of information and communications technologies to articulate an understanding of E-commerce (Yuan et al., 2022). The information and communications technologies are basically categorised as 'electronic sources of storing, processing, capturing, and communicating the information.' Similarly, E-commerce can be categorised as using information and communications technologies to store, process, capture, and communicate business information (Cheba et al., 2021). From the perspective of four viewpoints discussed earlier, E-commerce can be defined as conducting business-related transactions, sustaining business-related relationships, and transmitting business-related information by sources of telecommunications networks.' E-commerce comprises electronically maintained commercial transactions, including individuals and organisations (Sievering, 2020; Rizvi et al., 2022).

It is argued in the literature that adopting E-commerce opens up various opportunities for individuals, institutions, and organisations to achieve benefits, starting from a decline in transaction costs (Tang & Zhu, 2020). This decline in transaction costs leads to several interconnected E-commerce reimbursements that can influence the operational processes of a firm, trading associations, and strategic and informational means in the marketplace that significantly influence society's overall well-being (Octavia et al., 2020). Three objectives can mostly characterise these interconnected benefits of E-commerce. These objectives are operational, informational, and strategic. Strategic benefits of E-commerce are linked with refining market enactment of the business. Informational benefits of E-commerce are linked with refining marketplace communication and information (Arif et al., 2022; Ortolano & Nissi, 2022; Qin et al., 2021). E-commerce's operational benefits are linked to attaining efficiency and cost reduction in operations that simplify the delivery of products and services of the organisation in the marketplace (Anvari & Norouzi, 2016; Mirza et al., 2020; Ariansyah et al., 2021).

The global economy has transformed into digitalisation (Z. Chen et al., 2022; Umar et al., 2022). E-commerce is considered the most concentrated and active demonstration of the digitalised world and has speedily penetrated every field of life (Karim et al., 2022). Assessing the nexus between E-commerce and human well-being is worthwhile for several reasons. First, E-commerce between households and firms is experiencing inexorable and rapid growth that revolutionised the various aspect of social and economic life. Hence, it is mandatory to explore how E-commerce influences environmental sustainability. Second, the effect of E-commerce on environmental sustainability differs due to the difference in nature of shopping between materialistic consumption and e-shopping (Liang et al., 2021; Ma et al., 2022). E-consumers usually do not buy cars or houses online. However, E-consumers prefer to buy those goods and services which involve experience, such as attending concerts, going on holiday, and travelling. These kinds of experiences positively enhance human-well-being and ultimately increase environmental sustainability (Zhuo et al., 2022; Xu et al., 2022; Wang et al., 2020). Some studies reveal that the use of some technologies can be adopted to improve connectivity and creativity, such as personal computers, mobile phones, music players, and video and photo cameras that are directly connected to environmental sustainability (X. Guo et al., 2022; Ji et al., 2021). Lastly, E-commerce based shopping reports limited detrimental side effects as the consumer cannot exceed spending from the loaded amount onto the card. Previous literature reported that E-commerce positively impacts the environment by reducing energy consumption and increasing the efficiency of green transportation (Escursell et al., 2021; Hidayatno et al., 2019). E-commerce positively impacts green factor productivity (Cao et al., 2021). Thus, this argument ends with the positive impact of E-commerce on environmental sustainability(Gao et al., 2021).

In literature, the two-dimensional impact of E-commerce on environmental sustainability is found. One dimension supports a positive nexus between E-commerce and environmental quality while the other reports a negative association (Cheba et al., 2021). The supporters of the positive nexus between E-commerce and environmental sustainability argue that transportation is one of the major determinants of CO2 emissions. The literature argues that reduction in the use of the vehicle is one of the possible methods to reduce CO2 emissions (Chen & Reklev, 2014). E-commerce helps conduct business activities without travelling (Rao et al., 2021). It may help reduce CO2 emissions by allowing work from home and online shopping, thus positively improving the environment (Song et al., 2020). In contrast, supporters of the negative nexus between E-commerce and environmental quality argued that online shopping trend increases in societies due to internet use. The timely delivery of goods is demanded by customers, resulting in increased fuel consumption due to faster transportation for delivery services (Yuan et al., 2022). This increase in fuel consumption deteriorates environmental sustainability due to increased CO2 emissions.

The E-commerce industry played an important role during the COVID-19 pandemic in providing access to products timely, on which strict restrictions were imposed to protect people's health (Mirza et al., 2020). Resultantly, outstanding growth was experienced in the sale of goods, but due to lockdown policies, a great loss occurred in the tourism industry. The growth rate of E-commerces was recorded

at 10% in Europe during 2020, which was 14% during 2019. But it is forecasted that during 2021–2022 growth rate of E-commerce will increase to 12%. European Union environmental protection expenditures have intensified up to 54% during 2006–2021 (Lone et al., 2019). However, environmental protection expenditures as percentage of GDP remain stable throughout the period. European Union has approved Climate Law and is devoted to combating CO2 emissions up to 55% till 2030 that are determined to be climate neutral till 2050. The problem of pollution can be fixed via E-commerce.

From the above discussion, it is concluded that the importance of E-commerce cannot be denied in formulating environmental sustainability. However, the impact of E-commerce on environmental sustainability has not been explored previously. However, controversies exist in the current literature regarding the association between environmental sustainability and e-commerce. To fill this vacuum, our study investigates the impact of E-commerce on environmental sustainability for the first time. Our study delivers new evidence regarding the linkage between e-commerce and environmental sustainability. Our study provides a feasible pathway to achieve human progress through e-commerce approaches. The basic purpose of this study is to fill the existing gap in the literature by identifying the impact of e-commerce on environmental sustainability. This study will contribute to the prevailing literature in two ways. First, this study is the first time exploring the nexus between E-commerce and environmental sustainability. Second, this study discusses every aspect of E-commerce and its subjective impact on environmental sustainability. In the current digitalisation era context, our study delivers new empirical evidence regarding the association between environmental sustainability and e-commerce and provides policy implications for other economies searching for advanced environmental sustainability measures.

2. Theoretical framework, model, and methods

E-commerce simply refers to the trading between buyers and sellers without any physical catch-up. It eliminates the distance between consumers and sellers, making shopping easy and convenient. The positive role of e-commerce in socio-economic development is well documented (Sun et al., 2021). Furthermore, there exists strong empirical evidence that the socio-economic development of the society is positively related to various sectors of the economy, including environmental sustainability (Zhao et al., 2020). Therefore, we can confer that e-commerce, directly and indirectly, affect society's well-being, consequently, environmental sustainability. To investigate the impact of e-commerce on CO2 emissions, we develop the following model:

$$\begin{aligned} CO_{2,it} = {} & \varphi_0 + \varphi_1 EC_{it} + \varphi_2 GDP_{it} + \varphi_3 Internet_{it} + \varphi_4 RD_{it} + \varphi_5 Trade_{it} \\ & + \varphi_6 Education_{it} + \alpha_i + \varepsilon_{it} \end{aligned} \tag{1}$$

where the CO2 emissions (CO2) are dependent on e-commerce (EC), gross domestic product (GDP), internet users (Internet), research and development (RD), trade openness (Trade), Education, fixed effect (α_i) , and a random error term (ε_{it}). The data used in the analysis is longitudinal in nature. We have used the ordinary least

square (OLS) method as the baseline model. The OLS assumptions are strictly followed to get efficient and unbiased estimates. However, in the case of panel data, we may encounter a few problems, such as endogeneity, unobserved heterogeneity, etc., and the OLS technique provides biased and inefficient estimates. We have applied two-stage least square (2SLS) and generalised method of moment (GMM) techniques to control such issues. The extended model is:

$$\begin{aligned} CO_{2,\ it} = {} & \varphi_0 + \lambda_1 CO_{2,it-1} + \varphi_1 EC_{it} + \varphi_2 GDP_{it} + \varphi_3 Internet_{it} \\ & + \varphi_4 RD_{it} + \varphi_5 Trade_{it} + \varphi_6 Education_{it} + \alpha_i + \varepsilon_{it} \end{aligned} \tag{2}$$

The 2SLS is an extension of the OLS technique and provides efficient results if the disturbance term is correlated with some of the regressors. Similarly, the GMM estimator proposed by (Arellano & Bond, 1991) and (Blundell & Bond, 2000) also controls the issue of endogeneity by including lagged dependent variables. Further, the GMM method also controls the time and country-fixed effects. Both the methods provide similar results in the case of the exact equation, different results in the case of over identified equation, and fail to provide in the case of the unidentified equation. To sum up, 2SLS and GMM methods are instrumental variable techniques and are considered superior to OLS techniques for panel data analysis.

Lastly, we have also applied the advanced panel data technique known as panel quantile regression (PQR), which is used to get the regression model for all quantiles by regressing the independent variable of the provisional quantile of the dependent variable. Hence, it is a better method than the OLS technique because it is more suitable for explaining the impact of the independent variable on the range and provisional dispersal of the dependent variable. Moreover, the PQR is used to obtain the tail properties of variable dispersal. Lastly, the robustness of the PQR is much more than that of the OLS regression (Wei & Ullah, 2022).

3. Data

The study explores the impact of E-commerce on environmental sustainability for selected European economies from the period 2002–2019. These economies and data spans are selected based on data. CO2 and greenhouse gas emissions determine the dependent variables for environmental sustainability. The independent variable, E-commerce, is measured through internet purchases by individuals. Except these, GDP per capita, internet users, research and development, trade, and education are taken as control variables. GDP per capita is measured at constant 2015 US$. Internet users are taken as a percent of the population. Research and development expenditures are also taken as a percent of GDP. Trade is also measured as a percent of GDP. School enrolment at the tertiary level is taken to measure the role of education. The data for E-commerce is taken from Eurostat. At the same time, the data for dependent and all control variables are taken from the WDI. The detailed information about symbols and definitions of variables and data sources are given in Table 1. In Table 2, descriptive statistics cover the time period from 2002 to 2019 for selected European

Table 1. Definitions and sources.

Variables	Definitions	Sources
CO2	CO2 emissions (kt)	WDI
GHGs	Total greenhouse gas emissions (kt of CO2 equivalent)	WDI
E-commerce (EC)	Internet purchases by individuals	Eurostat
GDP	GDP per capita (constant 2015 US$)	WDI
Internet	Individuals using the Internet (% of population)	WDI
RD	Research and development expenditure (% of GDP)	WDI
Trade	Trade (% of GDP)	WDI
Education	School enrolment, tertiary (% gross)	WDI

Source: Author's Estimation.

Table 2. Descriptive statistics.

	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis
CO2	5.329	5.476	5.922	4.539	0.379	−0.447	2.098
GHE	5.419	5.576	5.988	4.649	0.379	−0.477	1.967
EC	47.56	49.5	86.00	5.000	22.19	−0.212	1.964
GDP	10.43	10.59	10.88	8.937	0.429	−1.997	6.314
INTERNET	1.836	1.889	1.977	1.309	0.137	−1.516	5.132
RD	1.984	1.933	3.579	0.539	0.785	0.183	2.114
Trade	4.391	4.392	5.114	3.816	0.366	0.463	2.081
Education	66.85	65.53	92.88	44.04	9.977	0.442	2.649

Source: Author's Estimation.

economies. The means of CO2, EC, GDP, Internet, RD, Trade, and education are 5.329 kt, 5.419 kt, 47.56%, 10.43, 1.836%, 1.984%, 4.391%, and 66.85%, respectively.

4. Results and discussion

To deduce the impact of E-commerce on environmental sustainability, our study adopted three regression techniques. These regression techniques are the OLS approach, the 2SLS approach, and the GMM approach. The result estimates of all three models are reported in Table 3. It is found that E-commerce reports a significant and negative impact on carbon emissions in the case of OLS and 2SLS models. It reveals that the development of E-commerce brings a significant reduction in carbon emissions. Thus, governments of European economies can adopt E-commerce as a policy tool to ensure environmental sustainability. The coefficient estimates describe that 1% development of E-commerce reduces carbon emissions by 0.005% in the case of the OLS model and 2SLS model.

The association between E-commerce and CO2 emissions is found to be negative in our study. This finding is also supported by (Liang et al., 2021), who argue that an upsurge in E-commerce stimulates using smart technology that reduces CO2 emissions. Moreover, E-commerce could be cost-effective and energy-saving, thus influencing energy demand (Sivaraman et al., 2008). Another study supported our findings by arguing that an upsurge in E-commerce could control the CO2 emissions of the retail industry (Zhao et al., 2020). E-commerce exerts a positive influence on environmental quality through various channels. E-commerce controls the use of vehicles in population-dense arrears, which causes a significant reduction in CO2 emissions (J. Guo et al., 2017). E-commerce improves environmental quality when digital methods of downloading are preferred over physical products (Zhang et al., 2022). Moreover, E-procurement, E-learning for travelling purposes, E-service, and

Table 3. Estimates of CO2 emissions (OLS, 2SLS, and GMM).

	OLS		2SLS		GMM	
	Coef.	t-stat	Coef.	z-stat	Coef.	z-stat
L.CO2					0.464***	7.010
EC	−0.005***	−2.930	−0.005***	−12.23	−0.006	−1.040
GDP	0.057***	5.850	0.345***	7.170	0.141***	4.860
internet	−0.112	−0.370	−0.126***	−2.810	−0.063**	−2.540
RD	−0.241***	−6.120	−0.007**	−2.350	−0.014**	−2.460
Trade	−0.363***	−5.970	−0.038	−0.760	−0.059**	−2.430
Education	−0.013***	−5.880	−0.012***	−4.010	−0.011***	−2.680
Cons	8.427***	11.84	1.763***	4.000	15.97***	6.940

Note: ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.
Source: Author's Estimation.

teleworkers can significantly reduce CO2 emissions (Rizvi et al., 2022). The negative nexus between E-commerce and CO2 is reported by (Cheba et al., 2021), who denoted that E-commerce provides less pollution services to building less, paperless, and less pollution. Transportation is highlighted as the major cause of pollution emissions, and reducing vehicle trips help reduce the pollution emissions. E-commerce may ease online shopping that significantly reduces transportation on roads. The study also highlighted that E-commerce enhance can reduce need for inventory and waste, operational cost of business, and need for warehouse space.

Studies reported that the successfully growing digitalised economy and the new business and industrial pattern signified by E-commerce have been rising rapidly, which plays a significant role in technological and industrial upgrades that increase environmental sustainability. Our findings are supported by (Zhao et al., 2019), which have explored how enterprises have reduced fossil fuel consumption by using E-commerce, improved resource allocative efficiency, and, henceforth, improved environmental pollution. (Pålsson et al., 2017) the study has backed our findings by arguing that e-commerce reduced pollutant emissions through the channel of trade and reduction in energy consumption. Some studies also argue that e-commerce improves commodity transportation effectiveness and controls vehicle pollutant emissions. E-commerce can improve productivity, energy consumption, transportation, and increase energy efficiency, thus stimulating renewable energy consumption and reducing pollution emissions.

The impact of GDP per capita on carbon emissions is found significant and positive in the case of all three models. The findings demonstrate that increased GDP per capita enhances carbon emissions significantly. The findings report that a 1% upsurge in GDP per capita enhances carbon emissions by 0.057% in the case of the OLS model, 0.345% in the case of the 2SLS model, and 0.141% in the case of the GMM model. Internet is found to be significantly and negatively associated with carbon emissions only in the case of the 2SLS and GMM models. The nexus between the internet and environmental sustainability is found statistically insignificant in the case of the OLS model. The results show that a 1% escalation on the internet reduces carbon emissions by 0.126% in 2SLS models and 0.063% in the GMM model. The association between research and development and carbon emissions is found to be significant and negative in the case of all three models. It infers that governments of European economies can enhance investment in the research and development sector to improve environmental sustainability. The coefficient estimates display that 1%

Table 4. Estimates of CO2 emissions (panel quantile regression).

Variable	$\tau = 25^{th}$ Coefficient	t-Stat	$\tau = 50th$ Coefficient	t-Stat	$\tau = 75th$ Coefficient	t-Stat
EC	0.002	1.099	−0.005***	−3.011	−0.008***	−4.875
GDP	0.137**	2.162	0.089**	2.251	0.011	0.086
INTERNET	0.290	1.156	−0.047	−0.141	−0.385**	−2.207
RD	−0.406***	−6.167	−0.320***	−9.774	−0.162***	−5.885
TRADE	−0.339***	−4.981	−0.350***	−11.69	−0.428***	−4.140
EDUCATION	−0.006**	−2.272	−0.009***	−7.060	−0.010***	−3.085
C	5.850***	7.500	6.998***	11.83	8.524***	6.031

Note: ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.
Source: Author's Estimation.

intensification in research and development reduces carbon emissions by 0.241% in the case of the OLS model, 0.007% in the case of the 2SLS model, and 0.014% in the case of the GMM model.

In the case of trade, it is found that trade reports a significant and negative impact on environmental sustainability in the case of OLS and GMM models. It reveals that an increase in trade activity significantly improves environmental sustainability. Thus, governments of European economies can increase trade activity to achieve environmental sustainability. The coefficient estimates describe that a 1% increase in trade activity reduces carbon emissions by 0.363% in the case of the OLS model and 0.059% in the GMM model. Education is significantly and negatively associated with carbon emissions in the case of all three models. The results show that a 1% upsurge in education level reduces carbon emissions by 0.013% in the OLS model, 0.012% in the 2SLS model, and 0.011% in the GMM model.

The nexus between E-commerce and environmental sustainability is also explored through panel quantile regression. Table 4 reports lower, medium, and upper quantile regressions results. E-commerce's significant and negative coefficients at medium and upper quantiles reveal that E-commerce increases environmental sustainability at medium and upper quantiles. These findings postulate that European economies are experiencing a significant improvement in E-commerce due to technological innovation and digitalisation, so these improvements bring significant change in environmental technologies that improve environmental sustainability. GDP reports a significant and positive increase in carbon emissions as confirmed by positive coefficient estimates of GDP at lower and medium quantiles. Internet reduces carbon emissions at upper quantiles in selected European economies. The research and development expenditures enhance environmental sustainability at lower, medium, and upper quantiles. Trade reports a significant and negative impact on carbon emissions as confirmed by negative coefficient estimates of trade at lower, medium, and upper quantiles. The results further reveal that education improves environmental sustainability at lower, medium, and upper quantiles.

To confirm the robustness of the findings, the study has used a variable-based robustness technique by changing the dependent variable by GHG emissions. The result estimates of all three robustness models are reported in Table 5. Table 6 reports the results for lower, medium, and upper quantile regressions in the case of robustness models. The findings displayed in both tables are quite similar to the findings of actual models.

Table 5. Estimates of GHGs (OLS, 2SLS, and GMM)-Robustness.

	OLS		2SLS		GMM	
	Coef.	t-stat	Coef.	z-stat	Coef.	z-stat
L.GHGs					0.494***	7.220
EC	−0.005***	−3.150	−0.005***	−12.82	−0.004*	1.750
GDP	0.073	1.120	0.300***	6.880	0.111***	4.380
internet	−0.133	−0.460	−0.142***	−3.510	−0.038*	−1.720
RD	−0.239***	−6.310	−0.007	−0.380	−0.012*	−1.870
Trade	−0.396***	−6.760	−0.045	−0.990	−0.048**	−2.290
Education	−0.013***	−6.080	−0.002***	−3.910	−0.001**	−2.480
Cons	8.768***	12.79	2.329***	5.830	14.21***	6.640

Source: Author's Estimation.

Table 6. Estimates of GHGs (panel quantile regression-Robustness).

	$\tau = 25$th		$\tau = 50$th		$\tau = 75$th	
Variable	Coefficient	t-Stat	Coefficient	t-Stat	Coefficient	t-Stat
EC	0.002	1.107	−0.006***	3.248	−0.008***	4.742
GDP	0.121**	1.988	0.068*	1.691	0.010	0.097
INTERNET	0.299	1.263	−0.089	0.369	−0.293	−1.069
RD	−0.396***	−6.364	−0.320***	−9.645	−0.151	−0.981
TRADE	−0.357***	−5.429	−0.395***	−12.91	−0.465***	−5.390
EDUCATION	−0.006**	−2.128	−0.010***	−6.894	−0.010***	−3.273
C	6.123***	8.059	7.318***	14.62	8.817***	8.300

Source: Author's Estimation.

5. Conclusion and implications

For the first time, this research provides an empirical investigation into the impact of E-commerce on environmental sustainability targets. The role of e-shopping on economic development has been explored in several studies. However, the effect of E-commerce on environmental sustainability has never been empirically explored. Thus, to fulfil this vacuum, the current study examines the impact of E-commerce on environmental sustainability targets in the case of selected European economies. These economies have been chosen based on data availability. For empirical investigation, the study adopts three different regression techniques. These techniques include OLS, 2SLS, and GMM. The study also adopts a panel quantile for deducing E-commerce impact on environmental sustainability targets.

The study reports the following findings based on these three regression approaches. First, E-commerce exerts a significant and negative effect on CO2 emissions in all three models. It reveals that E-commerce contributes significantly to enhancing environmental sustainability in this digitalised world. Second, trade is negatively associated with CO2 emissions, revealing that governments of selected European economies can intensify their trade activities to improve environmental sustainability. Third, the findings reveal that an increase in the GDP of any economy deteriorates environmental sustainability. Lastly, research and development, the internet, and education positively influence environmental quality by reducing CO2 emissions.

Based on these results, our study delivers various important policy implications. First, the policymakers should formulate policies that ensure the usage of ICT and E-commerce in society at each level that enhances environmental sustainability. The information technology sector should be flourished as it spreads knowledge about the use of E-commerce, human development, and green growth. The governments of

European economies should facilitate the provision of digital skills among people as it will help educate the individuals to avoid the harmful impacts of E-commerce. The study suggests that governments should promote and implement the e-commerce policy. Financial services, logistics availability, internet access, and proficiency in digital skills help in adopting e-commerce. Moreover, governments and higher authorities are responsible for increasing the awareness of individuals regarding the conveniences and advantages of e-commerce. Thus, governments should boost the compatibility of e-commerce with the needs of each individual. The European economies should expand investment in green infrastructure and enhance the use of clean energy consumption to improve environmental sustainability. The economic, social, and environmental aspects should be considered as a group to gain sustainability of E-commerce. The e-commerce industry should be promoted as it directly influences many aspects of society, such as transportation, congestion, and environmental protection. The government must encourage e-commerce by implementing ICT trade legislation and restricting energy consumption products' imports. Policymakers should encourage the growth of green solutions by reducing restrictions on the financial cost of eco-friendly projects and technologies.

Besides these findings and useful implications, our study contains several limitations, which need proper consideration in future studies. This study measures environmental sustainability through CO2 emissions and greenhouse gas emissions. However, other environmental sustainability measures are completely ignored, such as methane, nitrous oxide, and $PM_{2.5}$. These parameters should also be included in future analyses. E-commerce can significantly help the field of the energy sector in making payments online. Thus, in future studies, the E-commerce impact should also be explored on energy consumption. ICT development is mandatory in the successful applications of E-commerce. Thus, ICT role should be captured in future analysis.

Disclosure statement

No conflict of interest has been declared by the authors.

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