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The Connection of Income Inequality and Environmental Quality: A Focus on Tourism Development in Leading Muslim-majority Tourist Destinations

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ABSTRACT

The present study investigates the impact of tourism development on income inequality and environmental quality in 12 prominent Muslim-majority tourist-receiving countries using data spanning from 1990 to 2021. The research employs cross-sectional dependence and heterogeneity tests, followed by unit root and panel cointegration analyses. The findings, based on the Driscoll and Kraay estimator, indicate a positive association between income inequality and tourism development in the income inequality model. However, there exists a negative relationship between CO_2 emissions and tourism development. Additionally, the Dumitrescu & Hurlin causality test is employed to assess the directional causality among the study variables. The results of Causality test reveal a unidirectional causality from CO_2 emissions to income inequality and from tourist arrivals to income inequality. Notably, there is no observed causal relationship between tourist arrivals and CO_2 emissions in the panel of Muslim-majority countries.

Keywords: CO_2 emissions, income inequality, tourism development, Driscoll & Kraay, Muslim countries.

INTRODUCTION

The rapid globalization has accelerated the improvement in travel and tourism sector in various economies around the world. Particularly the expansions in modes of communication, reduced transport cost, all of this contributed in making the tourism and travel sector among leading sectors around the globe (Shakouri et al., 2017). Tourism has emerged as a leading sector globally because of its rising contribution in generating income, job creation, poverty reduction and raising the standards of living of millions of people worldwide. According to the World Bank report it accounts for job creation of 47.7 million in South Asia alone in 2019. The World Travel and Tourism Council (WTTC) is the finest partner for governments to create employment because this industry has created one-fourth of all jobs globally over the past five years (WTTC, 2020). In 2019 the Travel & Tourism sector accounted for 3.5% growth outperforming the world economy growth of 2.5% for the ninth consecutive year. The World Travel and Tourism Council (WTTC) estimates that in 2019, travel and tourism generated US$8.9 trillion, 10.3% of global GDP, US$330 million jobs globally.

On one hand, tourism sector has key role in enhancing the economic growth while on the other hand, the environmental issues associated with this sector have been debated on several platforms in last few decades. Tourism industry is one of the major constituents of the service sector and has extensive ability to influence environmental quality. Hence it is a serious concern for many environmentalists and policy makers around the world. Similarly, in last two decades' tourism industry has surpass the construction industry as one of the bigger polluters, contributing up to 8% of worldwide greenhouse gas emissions (Lenzen et al., 2018).

Moreover, with increasing population more and more industries are established, construction has been focused to fulfill the demands of growing population and the outcomes of these activities causes environmental degradation and polluting the environment. There has been a drastic rise in carbon dioxide emission globally in past decades and it is increasing at an unprecedented rate. CO_2 emission is a common issue of all countries because its emission is entirely responsible for causing global warming that needs to be dealt with efficiently and effectively. Some of the countries come up with the idea of low carbon tourism and in those countries despite rising tourism over years CO_2 emissions are same as rising very slowly. Likewise, numerous studies have already been led to examine the effect of tourism in influencing regional inequality (Mansour-Ichrakieh and Zeaiter, 2019; Rahnama et al., 2019). Tourism has a positive and negative impact on income inequality. For instance, (Zhang, 2021) revealed that tourism and income equality are positively related with each other. Contrary to this, (Tan and Morimoto, 2019) examine the negative impact of tourism development on income equality. Tourism is a sector with both forward as well as backward linkages (Cai et al., 2006). Efforts have been made earlier to combat poverty and ensure environmental sustainability by 2015 through millennium development goals of UN which were later replaced by sustainable development goals. The three sustainable development goals of no poverty, reduced inequalities within

and among countries and climate action out of a total of 17 goals that are meant to be achieved by the year 2030 globally (UNDP, 2021) could be achieved through Sustainable Tourism (UNWTO, 2022).

Although many studies have been conducted already that shows the effect of tourism on income inequality for developed and developing countries. Also, numerous studies have been carried out to inspect the economic impacts of the tourist sector but limited studies on the environmental degradation caused by tourism development in Muslim countries. Therefore, the key aim of this research is to explore how tourism affects income inequality and its effect on environmental quality. Moreover, the study also examined the influences of growth and trade on income inequality. This research will provide a new insight and contribute to the literature by examining the effects of tourism on income inequality and CO_2 emission for Muslim countries.

The first section of the study discusses introduction and literature review has been discussed in the second section. Also, the third section of the study presents information about the methodology employed, data sources and the variables used in the study. The results and discussion are given in 4th section and whole study is concluded in the last section.

LITERATURE REVIEW

CO_2 emission and tourist arrivals nexus

Dogan & Aslan (2017) results disclosed that tourism mitigates CO_2 emission Whereas, with an increase in energy consumption, carbon emissions also increase. The findings of the Granger causality test showed that uni-directional causality exists between tourism and carbon emissions. Similarly, Paramati et al. (2016) study outcomes advocated that tourism has a positive as well as substantial impact on CO_2 emissions in both developed as well as developing countries (Alam & Khan, 2025; Arooj et al., 2025). It was further found out those tourism effects carbon emissions more in developed economies as compared to the developing economies. Furthermore, the results of the Akadiri et al. (2018) showed that unidirectional causality is running from tourism to carbon emission in nine island states out of sixteen states. These results concurred with those of Adedoyin (2020) who considered a panel of seven tourism-dependent economies. The positive association between CO_2 emission and tourism is also observed in the study of Muhammad et al., (2020).

Likewise, Fethi & Senyucel (2020) research findings suggested that both dependent and independent variables are highly correlated. Also, the outcomes of panel granger causality test found the existence of a unidirectional causality running from tourism development to carbon emissions. Likewise, the results of Shakouri et al. (2017) showed that uni-directional causality runs from CO_2 emission to tourist arrivals. In addition to that, the study findings suggested that tourist arrivals have not only significant but also a positive impact on CO_2 emissions (Aurangzeb et al., 2024; Bhutto et al., 2025). Moreover, Sharif et al. (2017) findings showed that all the independent variables (FDI, GDP, Tourist arrivals) are positively related with the

carbon-dioxide emission. It was further concluded that there exists uni-directional causality between carbon dioxide and all the independent variables (Haq & Khan, 2024; Imran et al., 2024). The outcomes of the variance decomposition method proved the existence of a unidirectional causal relationship from tourist arrival to CO_2 emission.

Also, Kuo et al. (2012) findings revealed that increase in tourism receipts which was used as a proxy for tourism development will not only increase energy consumption but will increase carbon-dioxide emission too compared to number of visitors but this impact is limited. Amzath & Zhao (2014) results of correlation matrix showed that tourism development and carbon emissions are positively correlated (Iqbal et al., 2025). It was also found that tourism development contributes significantly in carbon emission in Maldives. Katircioglu (2014) results show that tourism development results in raising CO_2 emission and also energy consumption with a significant proportion. Gao & Zhang (2019) in their study investigated the effect of GDP, energy consumption and tourism development on environmental pollution which has been measured through six pollutants. Results of FMOLS revealed that an increase in tourism causes CO_2 to rise (Kanwal & Tasleem, 2025). Panel Granger causality test was also employed to check if there exists any causal relationship among the variables. Findings reveal the presence of unidirectional causality from tourism to CO_2.

Katircioglu, Feridun & Kilinc (2014) examined the association between tourism, energy consumption, and CO_2 emissions on Cyprus Island. Granger causality tests were applied and the findings of the test discovered that a uni-directional causality exists between international tourism and carbon-dioxide emissions. Al-Mulali et al. (2014) investigated the impact of tourism on carbon dioxide emissions from the transportation sector in 48 top international tourism from Americas, Middle East, Africa, Asia & Pacific, and Europe (Kiyani et al., 2023; Khan & Khan, 2020). Panel fully modified Ordinary Least Square was applied along with The Granger Causality test. Findings of the granger causality test revealed that tourism is a key factor that raises the level of CO_2 for Africa, Asia and the Pacific, the Americas, and the Middle East, Tourist arrival is not the source of CO_2 emissions from the transport sector in the European region.

Unlike rest of the studies the findings of Sekrafi & Sghaier (2018) were quite different. They inspected the impact of tourism on environmental quality using data from in Tunisia. Outcomes of Granger causality test depicted that there exists no causal relationship between tourism and that of carbon emissions (Shabbir et al., 2021; Shah et al., 2025). Whereas the findings of Kumara et al. (2017) revealed the existence of a uni-directional causality from environmental degradation to tourism development. On the other hand, Sghaier et al. (2018) came up with different results. Sghaier et al. (2018) conducted a study to investigate tourism development's effect on environmental quality and CO_2 emissions in above mentioned countries of North Africa. An autoregressive distributed lag model was employed for data analysis. Study findings show that tourism growth does affect environmental quality. Tourism was

found to be negatively related with environmental quality in Egypt. On the other hand, in the case of Tunisia it is positively related and in case of Morocco it is neutral.

CO_2 emission and income inequality nexus

Zhang & Zhao (2014) study findings revealed that in the case of China income growth and CO_2 emissions are positively related. Moreover, it was also found that the effect of income inequality on CO_2 emission varies region to region in China. In the Eastern region the impact of IIE on CO_2 emission was found to be more prominent compared to the western region. Similarly, Liu et al.(2019) used panel data to examine the link between CO_2 emissions and that of income inequality in China. Likewise, panel regression results showed that per capita income and CO_2 emission are positively related. Thus, it shows that widening income gap deteriorates environmental quality by increasing CO_2 emission (Shah, Ali, & Khan, 2025). Recently, Uddin et al.(2020) conducted a study on G7 countries to investigate the impact of income inequality on CO_2 emissions. Findings of the study suggested that the link between CO_2 and IIE in the G7 could be nonlinear (Taqi et al., 2022). From 1870 to 1880 IIE and CO_2 emissions were found to be statistically significant and were also positively related whereas, they were found to be negatively related from 1950 to 2000 (Shezad et al., 2024; Sheikh et al., 2022). Demir et al.(2019) study findings demonstrated that CO_2 emissions and inequality are positively related in short run. While the results of Vector Error Correction (VECM) granger causality suggested a unidirectional causality running from renewable energy and IIE to carbon emissions.

Income inequality and tourist arrival nexus

Various studies are available that investigated the relationship between tourism and income inequality. Of such studies Ghosh & Kumar (2021) results concluded that tourism income receipts has a positive and significant impact on the income inequality in this case unlike square of tourism receipts which is found to be negative with income inequality. Raza & Shah (2017) findings revealed that tourism revenue is not only positively related to IIE but it also has a significant impact on the dependent variable. The results of the Uzar & Eyuboglu (2019) found that increase in tourism has a positive impact on income inequality in Turkey. Likewise, the findings of Chi (2020) revealed that in the case of developing countries tourism has a substantial and long-run effect on IIE whereas in developed countries tourism has an insignificant long-run effect on IIE. Wen and Sinha (2009) suggested that with a huge rise in inbound tourism in China there has been a substantial rise in regional inequality. Lee & O'Leary(2008) results of generalized least squares (GLS) regression suggested that tourism and recreation has a positive relationship with IIE. Oviedo-garcía & González-rodríguez (2018) study findings suggested that tourism has not reduced inequality in the distribution of wealth.

A multi-country study conducted by Nguyen et al. (2020) found that various tourism activities affect income inequality differently. Moreover, the study findings further revealed that tourism whether national or international reduces income inequality and in low income countries tourism enhances income inequality (Uddin et al., 2025). Likewise the study of Wu (2020) concluded that all the tourism

indicators have a negative as well as statistically significant impact on the dependent variable which is IIE in developing countries and has insignificant impact in the case of developed countries. (Pant, 2011) study findings show that domestic tourism has a greater role to play in reducing IIE than international tourism.

Li et al.(2016) study findings found that regional inequality diminishes with tourism development. Furthermore, it was also concluded that domestic tourism has a significant role to play in reducing income inequality than international tourism. The findings of the Rahnama et al.(2018) study concluded that international tourism income has not only positive but also has a significant impact on poverty index. Kinyondo & Pelizzo (2015) study results suggested that although tourism development does have a positive impact on economic development and also that of employment but its impact on reducing income inequality in Tanzania is not prominent.

Results of both Mahadevan (2016) and Alam and Paramati et al. (2016) discovered that tourism and IIE are positively related. With increase in tourism, income inequality also increases. Lv (2019) found out results have shown that tourism effects income inequality negatively. However, Mahadevan & Suardi (2019) came up with quite different results and their study findings revealed that tourism growth does not affect the income distribution in considered countries. Lastly, panel VAR findings depicted that income inequality is not affected by tourism growth.

RESEARCH METHODOLOGY

The current study used data for the period 1990 to 2021 on top tourist arrival Muslim countries. The details of the variable description are given in Table 1. The study starts by estimating the pre-designed models in six detailed steps (Fig.1).

Model specification

In order to see the effect of tourism on income inequality and that of CO_2 emissions there are two Equations. The general Equations will be written as

$$GINI_{it} = \int (CO_2, TA, GDPpc, NR, UP, FR, CEXP, TO) \quad (1)$$

$$CO_2 = \int (EU, TA, NR, UP, FD, FR, TO, RE, NR) \quad (2)$$

$$\text{GINI}_{it} = \alpha_{1it} + \alpha_{2it}\text{CO}_2 + \alpha_{3it}\text{TA} + \alpha_{4IT}\text{GDPpc} + \alpha_{5it}\text{NR} + \alpha_{6IT}\text{UP} + \alpha_{7it}\text{FR} + \alpha_{8it}\text{CEXP} + \alpha_{9it}\text{TO} + \epsilon_{it} \quad (3)$$

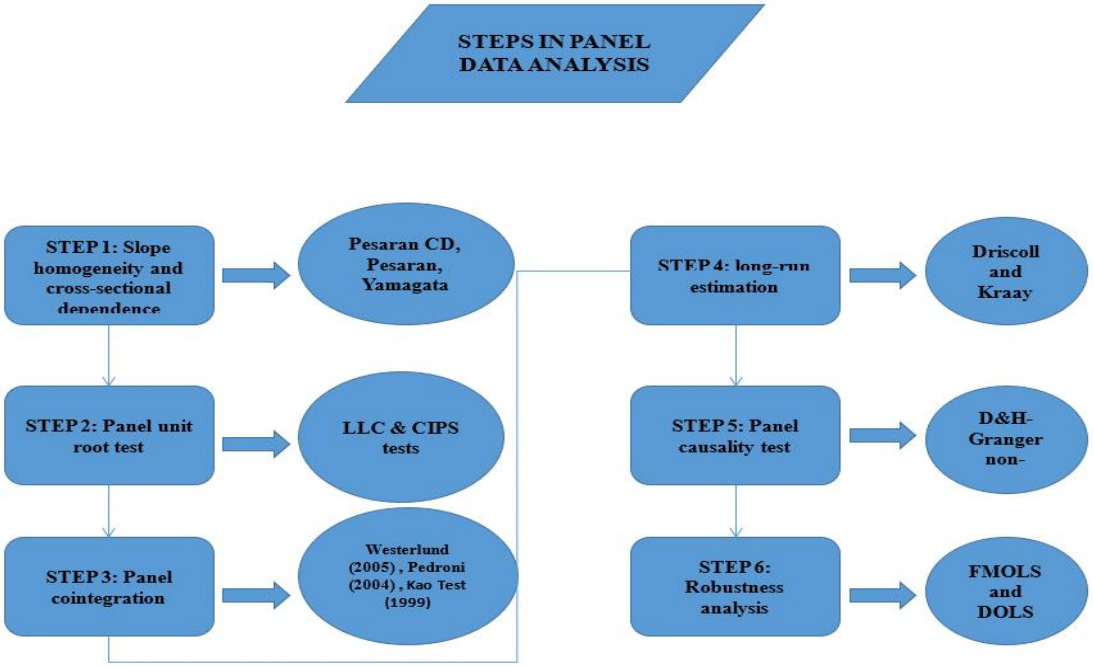
$$\text{CO}_{2it} = \beta_{1it} + \beta_{2it}\text{EU} + \beta_{3it}\text{TA} + \beta_{4it}\text{NR} + \beta_{5it}\text{UP} + \beta_{6it}\text{FD} + \beta_{7it}\text{FR} + \beta_{8it}\text{TO} + \beta_{9it}\text{RE} + \beta_{10it}\text{NR} + \mu_{it} \quad (4)$$

Where GINI_{it}, CO_{2it} ,TA_{it} , GDPpcit ,NR_{it} ,UP_{it} ,FR_{it}, CEXP_{it}, TO_{it}, EUit, FD_{it} and RE_{it} are GINI coefficient, carbon dioxide emission, international tourism, GDP per capita, Total natural resources rents, Urban population, Fertility rate, General government final consumption expenditure, trade openness, Energy use, Domestic credit to private sector and Renewable energy consumption respectively. The subscripts I represent countries (i = 1, ..., N) and t denote time (t = 1, ..., T).

Table 1: Variables Description

Variables	Symbols	Measurement	Source
Income inequality	*IIE*	%	SWIID
CO_2 emissions	*CO_2*	(kt)	WDI (2019)
International tourism,	*TA*	number of arrivals	✓
Fertility rate,	*FR*	total (births per woman)	✓
Urban population	*UP*	% of total population	✓
Energy use	*EU*	(kg of oil equivalent per capita)	✓
Financial development	*FD*	Domestic credit to private sector (% of GDP)	✓
GDP per capita growth	*GDPpc*	(annual %)	✓
General government final consumption expenditure	*CEXP*	(% of GDP)	✓
Renewable energy consumption	*RE*	(% of total final energy consumption)	✓
Total natural resources rents	*NR*	(% of GDP)	✓
Trade openness, annual	*TO*	US dollars at current prices in millions	UNCTAD

Figure 1 Steps in estimation



Slope homogeneity and cross-sectional dependence

Initial step for econometric estimation of current study is about slope homogeneity and cross-sectional dependence test which is a panel data problem. In the absence of these tests, results will be misleading (Hussain et al., 2020; Khan et al., 2020). The possible homogeneity of slopes cannot be overlooked due to country-specific impacts. As a result, before defining the variables' integration order, this study checks the slope homogeneity of the variables using the (Hashem Pesaran and Yamagata, 2008) test. They claim that by employing the deviation-adjusted statistic to account for normal distribution errors, the small sample features of the A statistic may be improved.

$$LM_{BP} = T\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\widetilde{\vartheta}_{ij}^{2} \quad (5)$$

Another concern in panel causality studies is determining whether or not there is cross-sectional dependency between nations. Cross-country and regional shocks are a major source of cross-sectional dependency (Chudik and Pesaran, 2015).]. Cross-sectional reliance among Muslim nations may exist. To account for the panel data set's cross-sectional dependency, this study employs the weak cross-sectional [46] test.

$$CD_p = \sqrt{\frac{2T}{N(N-1)}}\left(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N} r_{ij}^{2}\right) \quad (6)$$

Panel unit roots test

To check for spurious regression, panel unit root test has been employed. Levin, Lin, and Chu (2002), as well as Pesaran CIPS tests, were used for this purpose. The CIPS statistic introduced by Pesaran (2007) can be expressed as follows

$$CIPS = \frac{1}{N}\sum_{i=1}^{N} CADF_i \quad (7)$$

A panel cointegration

Following that, after checking for stationarity and verifying that all the variables are integrated of order (1), the variables are examined for cointegration. Several cointegration tests have been established in panel data econometrics, including Pedroni (2004), Westerlund (2005) cointegration and Kao (1999) residual based cointegration. Considering the benefits of each test, all three cointegration tests were used in this investigation.

Long-Run estimation

To examine the effect of tourism development on income inequality and carbon emissions the (Driscoll and Kraay, 1998) approach is used in the study. DK is suitable for data having cross-sectional dependence and heterogeneity problem (Driscoll and Kraay, 1998). Likewise, this estimator works well in both balanced panel and unbalanced panel; it produces good results even when missing observations, spatial and serial dependence, and heteroscedasticity are present (Baloch et al., 2021)]. Lastly, DK is a non-parametric approach; it is adaptable and does not impose any constraints as T grows (Driscoll and Kraay, 1998).

Panel Causality Test

Because of its relevance in policy development, causal analysis is becoming more important in empirical research. Thus we used a "panel-based Granger non-

causality presented by (Dumitrescu and Hurlin, 2012)]" (D-H) in the analysis to find any causal linkages between the variables.

The following model is used to confirm the causal relationship between variables.

$$Y_{it} = \beta_i + \sum_{K=1}^{K} \tau_i^{(k)} Y_{i,t-k} + \sum_{K=1}^{K} \delta_i^{(k)} X_{i,t-k} + \varepsilon_{i,t} \quad (8)$$

Where βi represents the intercept term, K denotes lag length, $\tau^{(k)}_i$ characterizes lag parameter $\delta_i = \left(\delta_i^{(1)} , \delta_i^{(2)} , \ldots\ldots\ldots \delta_i^{(k)}\right)$, and $\delta_i^{(k)}$ represents the slope coefficient. $\tau_i^{(k)}$ and $\delta_i^{(k)}$ represents the differences between the cross-section units.

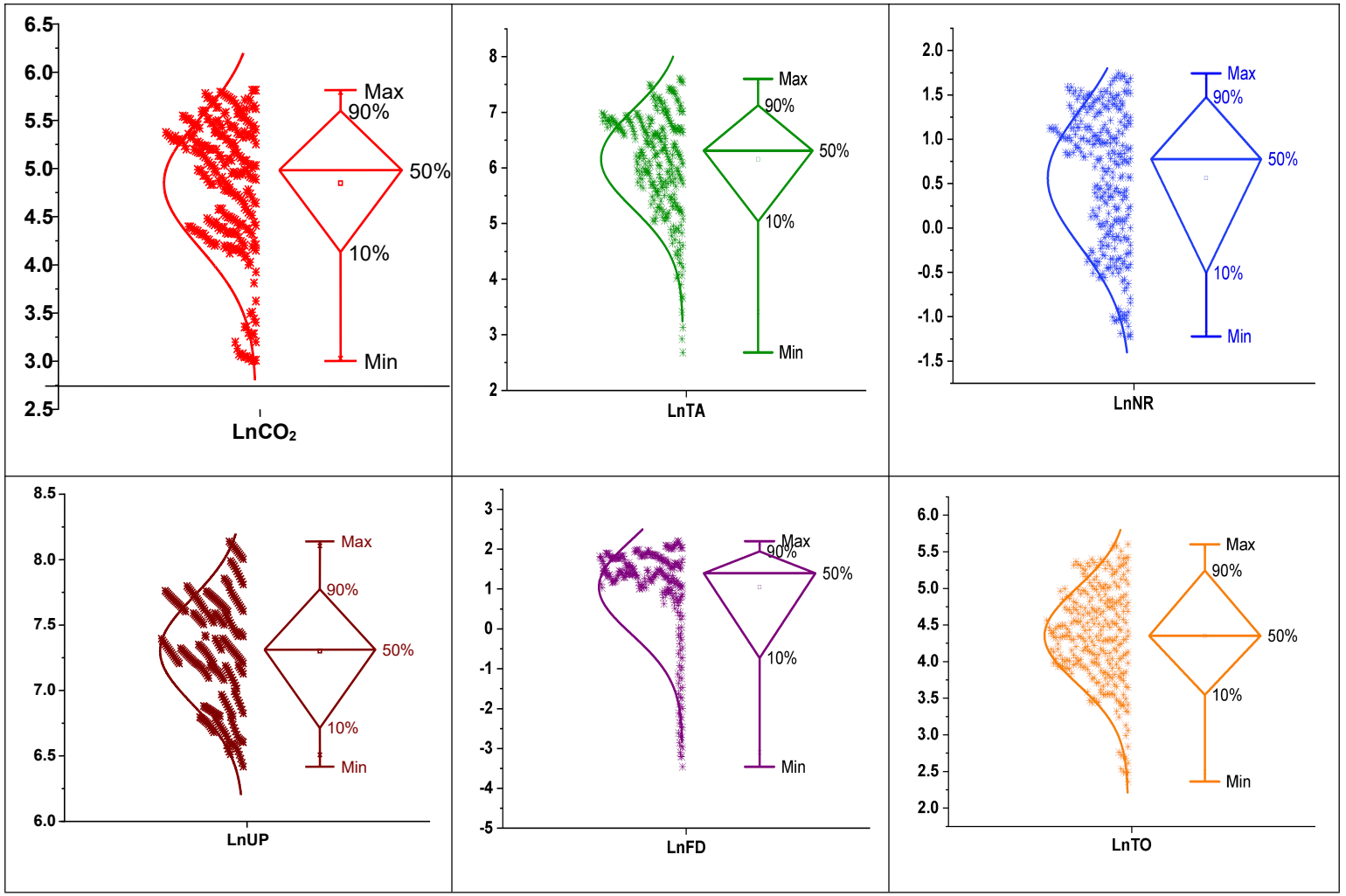
Robustness analysis

We used FMOLS and DOLS in our study to compare the results with the results found from Driscoll Kraay (DK) estimator. Fully modified ordinary least square and DOLS have been introduced by (Phillips and Hansen, 1990) and (Stock and Watson, 1993) respectively. The DOLS estimator was chosen because of its efficient findings. FMOLS is regarded as an effective estimate in the case of sample size since it does away with the issues of endogeneity and serial correlation between the variables (Hamit-Haggar, 2012). In 1993, (Stock and Watson, 1993) create a DOLS calculation. When cross-sectional dependence exists, these two estimators deliver effective and reliable results [53]. The FMOLS and DOLS estimators were chosen to examine the reliability of DK findings based on the previously mentioned characteristics.

DATA ANALYSIS AND RESULTS

Data description

Figure.2 provides a scatter and distribution diagram of Income inequality, Carbon emissions, international tourism, Fertility rate, Urban population, Energy use, financial development, GDP per capita growth, General government final consumption expenditures, Renewable energy consumption, Total natural resources rents, Trade openness, annual for a panel of 12 Islamic countries. The square represents the average value of the variables. Whereas horizontal bars represent the median values and the dots show the minimum / maximum values. The bottom edge of the box shows the 10th percentile, and the top edge indicates the 90th percentile.


6.5
6.0
5.5
5.0
4.5
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3.0
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Max
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LnCO2
8
7
6
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2
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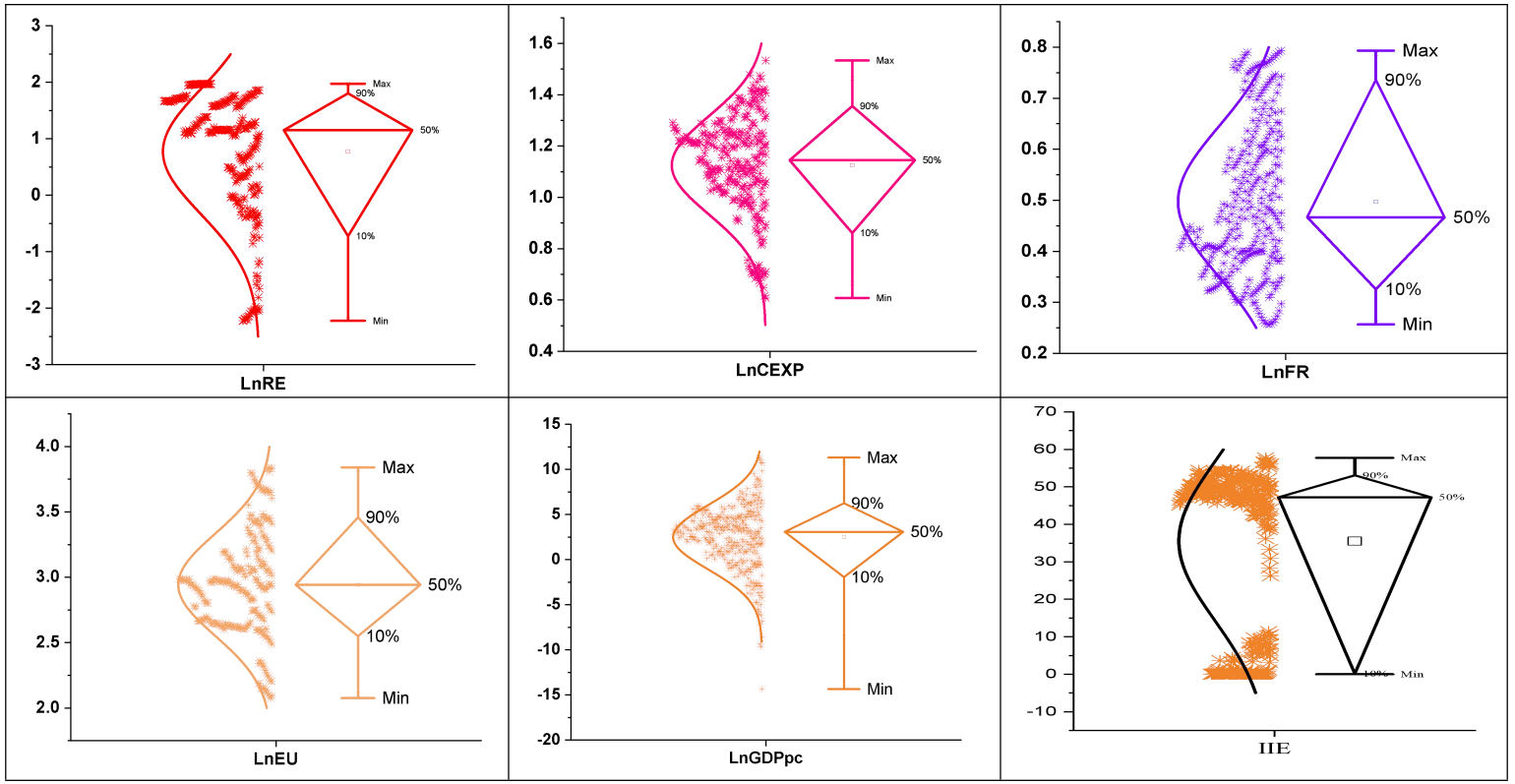

Figure 2 Data description

Results of Slope homogeneity and cross-sectional dependence

Table 2 depicts the results of slope homogeneity and cross-sectional dependence test. Slope homogeneity for income inequality and CO_2 emissions were tested. Similarly, cross-sectional dependence of individual variables was also tested. The result of cross-sectional dependence test shows the presence of cross-sectional dependence in the panel data.

Table 2 Slope homogeneity (Pesaran, Yamagata. 2008) and weak cross-sectional dependence (Pesaran, 2015)

Models	***SH-statistics***	***Variable***	***CD-statistic***
Income inequality model		$lnCO_2$	38.161***
Δ	*7.164***	LnTA	33.191***
Δ^{adj}	9.990***	lnGDPpc	2.852***
CO_2 emissions model		LnNR	16.72***
Δ	7.090***	LnUP	41.01***
Δ^{adj}	*9.038***	LnFR	37.092***
		LnCEXP	3.393***
		LnTO	39.312***
		LnEU	28.734***
		LnFD	10.809***
		LnRE	16.16***
		NR	16.72***

Note: *** p<0.01, ** p<0.05, * p<0.1, CD test null hypothesis: errors are weakly cross-sectional dependent,

Panel unit roots tests results

Unit root test is used to determine the order of integration of the variables. Examining the stationarity properties of variables is a prerequisite for obtaining long run Cointegration relationship. The current study used Levin-Lin Chu and CIPS unit root test and results are reported in table 3. The results of the LLC (2002) unit root test indicate that at level income inequality, fertility rate, GDPpc and RE were found to be stationary whereas, at 1st difference all the variables named as carbon dioxide emission, Income inequality, International tourism, financial development, trade openness, fertility rate, technological development, UP, GDP per capita, energy use, CEXP, Total natural resources rent and Renewable energy consumption are stationary. For robust analysis CIPS unit root test was also used to determine the stationarity of the variables. Results revealed that the results of the CIPS unit root test are in accordance with the LLC unit root.

Table 3 LLC & CIPS tests of unit roots

Variable	Level		1st difference		CIPS-statistics			Integration order
	LLC-statistics	p-values	LLC-statistics	p-values				
					Constant	Constant and Trend	No Constant nor trend	
IIE	-2.2096	0.0136	-5.8885	0.0000	-5.649	-5.969	-5.756	I[0]
CO_2	3.8148	0.9999	-5.6189	0.0000	-2.093	-2.733	-6.120	I[1]
TA	-0.7842	0.2165	-5.1694	0.0000	-5.557	-5.861	-1.540	I[1]
FR	-17.8271	0.0000	-13.1913	0.0000	-3.109	-2.612	-1.649	I[0]
UP	5.3811	1.0000	-1.8744	0.0304	-2.786	-2.727	-2.193	I[1]
EU	-1.2794	0.1004	-4.4975	0.0000	-2.522	-5.045	-1.845	I[1]
TO	2.1277	0.9833	-2.9703	0.0015	-5.769	-5.854	-5.779	I[1]
FD	0.9936	0.8398	-22.8513	0.0000	-5.994	-2.660	-6.036	I[1]
GDPpc	-5.2526	0.0000	-15.8514	0.0000	-4.025	-4.352	-3.941	I[0]
CEXP	-1.0236	0.1530	-7.2125	0.0000	-4.802	-4.944	-1.724	I[1]
RE	-2.9210	0.0017	-8.4067	0.0000	-4.670	-5.043	-4.717	I[0]
NR	-0.6496	0.2580	-7.0319	0.0000	-2.904	-2.861	-2.592	I[1]
Level of significance			1%			5%	10%	
CIPS-constant and trend (critical values)			-2.96			-2.76	-2.66	
CIPS-Constant (critical values)			-2.45			-2.25	-2.14	
CIPS-no Constant nor trend (critical values)			-1.87			-1.65	-1.53	

Results of panel cointegration tests

Results of Westerlund (2005), Pedroni (2004) and Kao (1999) cointegration are presented in table 4. The p-values of the group statistics and probability statistics in income inequality are significant at 1%. Similarly, for carbon dioxide the p-values of the group statistics and probability statistics are significant at 5% and 10% respectively. Thus, the results of both Pedroni as well as Kao cointegration test provide sufficient proof that the variables under consideration are cointegrated in selected panel.

Table 4 Results of panel cointegration

Westerlund (2005) cointegration	*Income inequality-Eq*	*CO_2 emissions-Eq*
Some panels are cointegrated (VR)	3.1179 ***	-1.6378**
All panels are cointegrated (VR)	2.7486 ***	-1.5853*
Pedroni (2004) cointegration		
Phillips-Perron t	-1.4028 *	-3.0680***
Augmented Dickey-Fuller t	-3.3397 ***	-2.6741***
Kao Test (1999)		
Modified Dickey-Fuller t	-2.1043 **	-2.7993 ***
Dickey-Fuller t	-1.9259 **	-1.3037 *
Unadjusted modified Dickey-Fuller t	-3.1912 ***	-2.8387 ***
Unadjusted Dickey-Fuller t	-2.4077 ***	-1.3203 *

Note: Values in parenthesis are (*p-values*), VR is variance ratio.

Results of long-run estimations

The results of Driscoll and Kraay estimate are tabulated in Table 5. Findings of IIE model revealed that CO_2 emissions, international tourism, fertility rate, Trade openness, General government final consumption expenditure and urban population are highly significant. It means that all of these variables have a significant impact on IIE. Moreover, CO_2 emissions, international tourism, fertility rate and GDP per capita are positively related with IIE. It means that 1-unit increase in CO_2 emissions, international tourism, fertility rate and GDP per capita will increase income inequality by 2.09, 1.27, 4.57 and 0.54 units respectively. Contrary to this trade openness, general government final consumption expenditure and urban population are found to be negatively related with income inequality. With increase in income inequality the environmental quality deteriorates and thus results in increasing carbon emissions. The positive effect of IIE on CO_2 emissions has also been supported by Liu et al. (2019).

In Eq.4 energy use, international tourism, fertility rate, trade openness, urban population, total natural resources rent and renewable energy consumption are found to be highly significant at 1% level. Only financial development is found to be significant at 10%. A unit increase in EU will increase carbon dioxide emissions by 0.56 units. Likewise, 1-unit increase in trade openness and urban population will increase CO_2 emissions by 0.38 and 0.94 units respectively. Unlike this international tourism, fertility rate, NR, RE and FD are found to be negatively related with CO_2

which is the dependent variable. It means that a unit increase in international tourism, fertility rate, total natural resources rents and RE and FD will decrease CO_2 by 0.13, 0.36, 0.03, 0.21 and 0.01 units respectively. Our findings depict a negative relationship among tourist arrivals and CO2 emission as supported by Dogan & Aslan (2017) unlike that of the outcomes found by Koçak et al.(2020), Nepal et al. (2019), Akadiri et al. (2018), Raza et al. (2017), Sharif et al. (2017), and Solarin (2014) whose findings found a positive impact of tourist arrivals on CO_2 emissions. Reduced CO_2 emission because of rising tourism in sample countries is because religious, historical, cultural and sports tourism dominate in these countries. Due to rising number of tourist arrivals over years, the income level increases. This in long term results in reducing pollutants.

Table 5 Results of Driscoll and Kraay estimate

Independent Variables	*Equation 3 Income inequality-model*	*Equation 4 CO_2 emissions-model*
lnCO₂	2.099***	–
Lanta	1.272***	-0.135***
LnFR	4.578***	-0.362***
LnUP	-1.414***	0.949***
LnEU	–	0.563***
LnTO	-2.381***	0.380***
LnFD	_	-0.0132*
LnGDPpc	0.543**	_
LnCEXP	-2.958***	_
LnRE	_	-0.215***
LnNR	0.0582	_
NR	_	-0.0345***
Constant	10.33***	-9.306***
Number of obs	384	384
Number of groups	12	12

Results of Panel Causality Test

With an intention to inspect the causal relationship among variables an advanced version of granger causality test is used. Table 4 provides the results of Dumitrescu & Hurlin causality test for Eq.3 (income inequality) and Eq.4 (CO_2 emissions). The results of the Dumitrescu & Hurlin causality test revealed the existence of bidirectional causality between income inequality and GDPpc, IIE and UP, income inequality and fertility rate. Similarly, there is unidirectional causality running from carbon dioxide emission to IIE, TA and TO to IIE. Contrary to this, no causal relationship was found between income inequality and natural resource and income inequality and General Government final consumption expenditure. In Eq.3 there exists bidirectional causality amongst CO_2 emissions and EU, urban population and CO_2 emissions, FD and CO_2 emissions, TO and CO_2 emissions, CO_2 and fertility

rate. Likewise, there was unidirectional causality running from CO_2 emissions to RE and CO_2 emissions to natural resource. Whereas no causal relationship was found to exist between TA and CO_2 emissions in the case of Islamic countries.

Table 6 D&H-Granger non-causality test results

Income Inequality model			
Null hypothesis	**Z-bar tilde**	**p-value**	**Remarks**
lnIIE ≠> $lnCO_2$	1.2366	0.2162	Accept null
$lnCO_2$ ≠> lnIIE	5.4345***	0.0000	Reject null
lnTA ≠> lnIIE	3.8910***	0.0001	Reject null
lnIIE ≠> lnTA	1.1061	0.2687	Accept null
LnIIE ≠> GDPpc	2.2006**	0.0278	Reject null
GDPpc ≠>LnIIE	4.7425***	0.0000	Reject null
lnNR ≠> lnIIE	-1.3834	0.1665	Accept null
lnIIE ≠> lnNR	0.1707	0.8645	Accept null
lnUP ≠> lnIIE	7.9615***	0.0000	Reject null
lnIIE ≠> lnUP	40.6649***	0.0000	Reject null
lnIIE ≠> LnFR	16.7695***	0.0000	Reject null
lnFR ≠> lnIIE	4.5802***	0.0000	Reject null
lnIIE ≠> lnCEXP	0.8667	0.3861	Accept null
lnCEXP ≠> lnIIE	0.2838	0.7766	Accept null
lnTO ≠> lnIIE	3.7877***	0.0002	Reject null
lnIIE ≠> lnTO	0.5222	0.6015	Accept null

CO_2 emissions model			
Null hypothesis	**Z-bar tilde**	**p-value**	**Remarks**
$lnCO_2$ ≠> lnTA	-0.2110	0.8329	Accept null
lnTA ≠> $lnCO_2$	-0.9818	0.3262	Accept null
lnEU ≠> $lnCO_2$	2.2076**	0.0273	Reject null
$lnCO_2$ ≠> lnEU	3.8739***	0.0001	Reject null
lnUP ≠> $lnCO_2$	8.7335***	0.0000	Reject null
$lnCO_2$ ≠> lnUP	7.3626***	0.0000	Reject null
lnFD ≠> $lnCO_2$	3.3611***	0.0008	Reject null
$lnCO_2$ ≠> lnFD	6.6025***	0.0000	Reject null
lnTO ≠> $lnCO_2$	4.6375***	0.0000	Reject null
$lnCO_2$ ≠> lnTO	2.8998***	0.0037	Reject null
$lnCO_2$ ≠> lnFR	48.3773***	0.0000	Reject null
lnFR ≠> $lnCO_2$	5.3818***	0.0000	Reject null
$lnCO_2$ ≠> lnRE	7.1752***	0.0000	Reject null
lnRE ≠> $lnCO_2$	0.2944	0.7684	Accept null
NR ≠> $lnCO_2$	-0.6101	0.5418	Accept null
$lnCO_2$ ≠> NR	2.0646**	0.0390	Reject null

Note: D&H is Dumitrescu & Hurlin (2012) Significance at * p<0.1, ** p<0.05, *** p<0.01

Results of Robustness Analysis

Table 7. displays the findings of FMOLS. FMOLS was used to examine the effect of carbon dioxide emission, international tourism, GDPpc, Total natural resources rents, UP, Fertility rate, General government final consumption expenditure and trade openness on IIE in the long run in Eq.3. In Eq.4 FMOLS was used to assess the impact of international tourism, urban population, fertility rate, trade openness, energy use, financial development, Renewable energy consumption and Total natural resources rents on carbon dioxide emission in the long run. Since the FMOLS considers the shortcomings of endogeneity and serial correlation, the results of this analysis are meaningful and robust. Results of Eq.3 depicted a significant and positive impact of CO_2, International tourism, GDP per capita and fertility rate on IIE in the case of Islamic countries. An increase in CO_2 by 1unit will cause income inequality to increase by 2.60 units. Likewise, an increase in international tourism by 1 unit will cause IIE to increase by 1. 75 units. Similarly, 1-unit increase in GDP per capita and fertility rate by 1 unit will cause income inequality to increase by 1.11 and 5.11 units respectively. Whereas urban population, General government final consumption expenditure and trade openness are statistically significant at 1% and are negatively related to income inequality. Thus, we can say that an increase in urban population, General government final consumption expenditure and trade openness by 1 unit will cause income inequality to decrease by 1.20, 2.83 and 3.12 units respectively.

In the case of Eq.4 International tourism, urban population, fertility rate, trade openness, energy use, Renewable energy consumption and NR are statistically significant at 1% whereas financial development is significant at 5%. Moreover, International tourism, fertility rate, financial development, RE and NR are negatively related with CO_2 emissions and UP, TO and energy use are positively related with CO_2 emissions.1 unit rise in international tourism, fertility rate, Renewable energy consumption and Total natural resources rents will cause CO_2 emissions to decrease by 0.29, 0.67, 0.04, 0.22 and 0.03 units respectively.

Table 7 FMOLS regression results

Variables	Income inequality model	CO_2 emissions model
Ln CO_2	2.601875***	
	(0.726690)	
LnTA	1.751821***	-0.297372***
	(0.374888)	(0.040701)
LnFR	5.116329***	-0.676538***
	(1.532153)	(0.189478)
LnUP	-1.205181***	0.453495***
	(0.347783)	(0.046628)
LnEU		0.295585***
		(0.104662)

LnTO	-3.122652***	0.740027***
	(0.887954)	(0.076440)
LnFD		-0.043042**
		(0.017194)
LnGDPpc	1.118610**	
	(0.437821)	
LnCEXP	-2.833460***	
	(1.020368)	
LnRE		-0.222398***
		(0.036667)
LnNR	0.200198	
	(0.239172)	
NR		-0.036217***
		(0.006727)
R-Squared	**0.263700**	**0.938625**

Note: *** p<0.01, ** p<0.05, * p<0.1

Table 8. shows the results of DOLS were used to examine the effect of carbon dioxide emission, international tourism, GDPpc, Total natural resources rents, UP, fertility rate, General government final consumption expenditure and trade openness on IIE in the long run in Eq.3. In Eq.4 DOLS was used to investigate the effect of international tourism, urban population, fertility rate, trade openness, energy use, financial development, RE and NR on carbon dioxide emission in the long run. In Eq.3 CO_2, International tourism, fertility rate and to are statistically significant at 1%, General government final consumption expenditure is significant at 5%, GDP per capita and up are significant at 10%. Carbon dioxide emission, international tourism, GDP per capita, natural resources rents and fertility rate are found to be positively related to income inequality.1 unit rise in carbon dioxide emission, international tourism, GDP per capita, natural resources rents and fertility rate will cause income inequality to increase by 1.91, 1.26, 0.55, 0.05 and 4.69 units respectively. Unlike this urban population, General government final consumption expenditure and trade openness are negatively related with income inequality. 1 unit rise in urban population, General government final consumption expenditure and to will decrease income inequality by 0.79, 2.23 and 2.37 units respectively. In Eq.4 International tourism, fertility rate, FD, RE and NR are negatively related with carbon dioxide. It means that with 1-unit increase in international tourism, fertility rate, financial development, Renewable energy consumption and Total natural resources rents will cause income inequality to decrease by 0.33, 0.670.05, 0.21 and 0.03units respectively. Similarly, urban population, trade openness and energy use are positively related with carbon dioxide. 1-unit increase in urban population, trade openness and energy use will cause carbon dioxide to increase by 0.45, 0.74 and 0.37units respectively.

Table 8 DOLS regression results

Variables	Income inequality model	CO_2 emission model
$LnCO_2$	1.912140***	
	(0.609383)	
LnTA	1.268856***	-0.332119***
	(0.336949)	(0.050147)
LnFR	4.690428***	-0.674618***
	(1.396850)	(0.198907)
LnUP	-0.793391*	0.450434***
	(0.308432)	(0.049814)
LnEU		0.373004***
		(0.118787)
LnTO	-2.379282***	0.745789***
	(0.745128)	(0.083199)
LnFD		-0.051250**
		(0.020251)
LnGDPpc	0.559547*	
	(0.333789)	
LnCEXP	-2.230937**	
	(0.930802)	
LnRE		-0.215090***
		(0.043976)
LnNR	0.056917	
	(0.206452)	
NR		-0.038591***
		(0.008141)
R-Squared	0.271224	0.950477

Note: *** p<0.01, ** p<0.05, * p<0.1

CONCLUSION AND RECOMMENDATIONS

This study analyzed the impact of tourism development on IIE and environmental quality in 12 Muslim countries. Thus, the results of Westerlund, Pedroni as well as Kao cointegration test provides sufficient evidence that the variables under consideration are cointegrated in the panel of 12 Muslim countries. Moreover, the long-term estimation confirms that tourism development exerts a positive as well as statistically significant impact on income inequality. Whereas, tourism development although had a significant but was found to be negatively related with environmental quality which confirms the findings of Shakouri et al. (2017). The results of the Dumitrescu & Hurlin (2012) Granger causality test revealed that there is bidirectional causality between IIE and GDP per capita, IIE and urban population IIE and fertility rate, CO_2 emissions and EU, urban population and CO_2 emissions, FD and CO_2 emissions, TO CO_2 emissions, CO_2 and fertility rate. Similarly, a unidirectional causality was found to be running from carbon dioxide emission to income inequality, Tourist arrivals and trade openness to income inequality, CO_2 emissions to RE and CO_2 emissions to natural resources.

The current suggests that the government should implement regulations and provide financial and other support to small and medium-sized businesses in order for them to compete with major multinational corporations. Because multinational corporations drive small and medium-sized businesses out of business and establish monopolies, thus it results in increasing income inequality. On the other hand, the government ought to pay special attention to efficient redistribution measures. The impoverished should receive assistance from social welfare programs funded with the money the government collected from the travel and tourism industry. Additionally, the unskilled labor employed in the tourism industry is being paid low wages which further widens the income gap between the rich and the poor. Therefore, government needs to set minimum wages for the labors so that they will not be exploited by the business owners. To encourage equitable income distribution, the government should regularly review its pay rules and make adjustments as necessary. The other policy measures need to undertake are implementation of efficient redistribution measures and government must concentrate on modernizing financial systems to encourage trade activities including trade opening and liberalization, which have the potential to spur greater levels of development and reduce CO_2 emissions.

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